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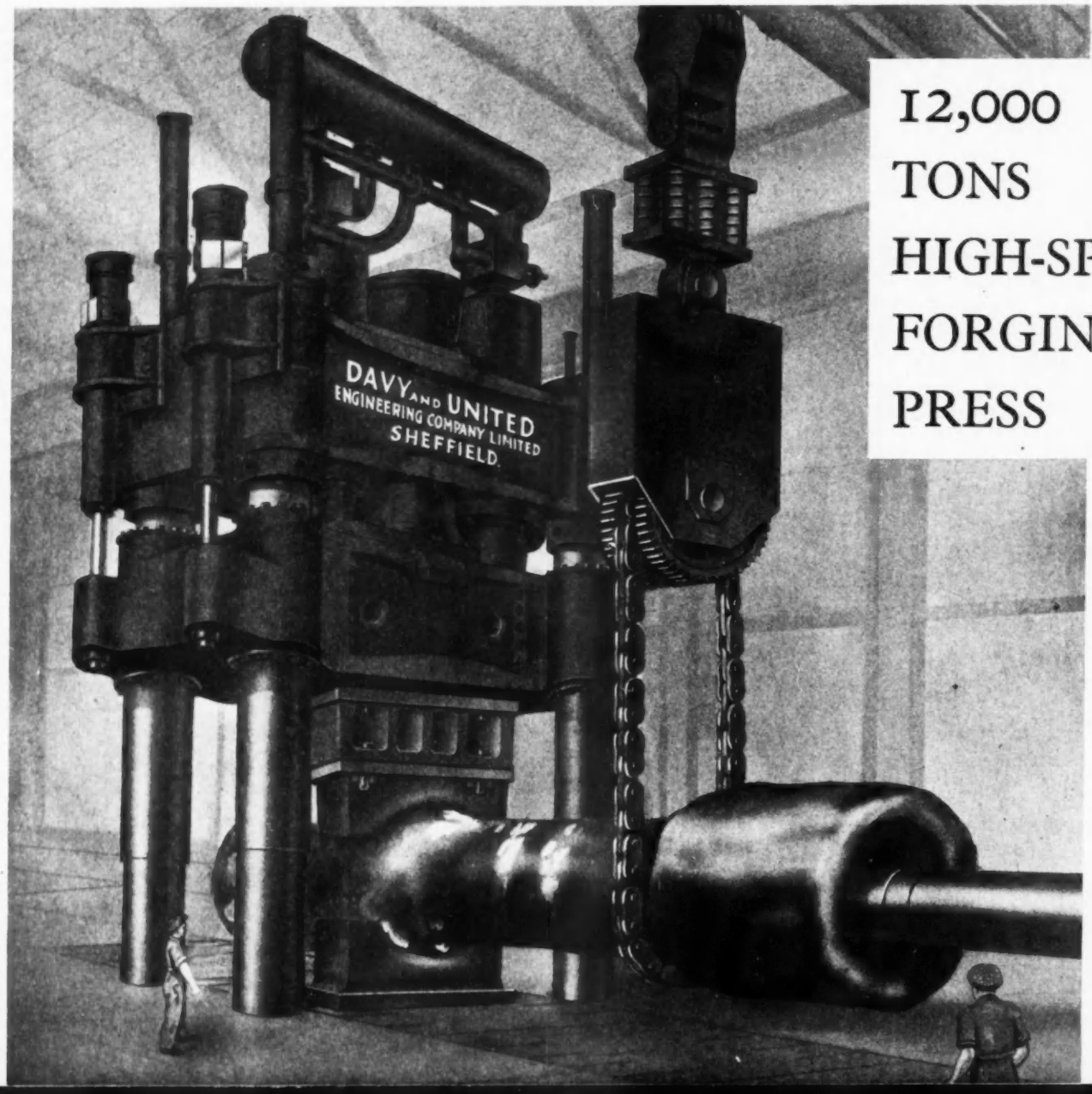

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WELDED RIGID-FRAME FACTORY BUILDING.

By O. BONDY, M.I.Struct.E.

(*Concluded from page* 283.)

Assembling and Welding in Shop.—Certain difficulties were experienced with some of the heavier sections, as, for example, the 24 in. by 7½ in. by 95 lb. joists for the gantry girders. These were intended to be straight when delivered from the rolling mills, but, in fact, some of the girders were distorted and showed marks of strain in the webs. By adopting suitable procedure when welding the 12 in. by ½ in. top plates, and by adjusting the bolted seats, the workshop succeeded in producing perfectly straight gantry girders. The flange plates for the main portals, 10 in. and 12 in. wide, were rolled as universal flats to exact width and the rolled edges proved to be a definite advantage. These plates, up to 1¼ in. thick, had to be bent to exact shape and particular care was taken in preparing their ends for butt welds of U-shape, by means of modern scarfing machines. Figs. 36 to 45, on this page, show some of the butt welds which were used for the main portals. Accurate machining and assembling is essential to produce butt welds of this type, of 100 per cent. efficiency. Fig. 36 shows the welding of the portal at the apex, details of the top and bottom flange weld being given in Figs. 37 and 38. The rafter top flange weld is shown in Figs. 39 and 40, and the corner and flange weld in Fig. 41. Two elevations and a plan showing the flange weld where thicknesses are different are given in Figs. 42 to 44, and a detail of the web weld in Fig. 45.

Testing.—It was felt that various features of design and production of this structure had not before been adopted as a matter of general practice in this country, and a confirmation of certain assumptions by practical tests was, therefore, welcomed. Another reason for giving perhaps more attention than usual to the matter of testing was the information about failures with welded structures which became available at that time both from Belgium and Germany, culminating in the collapse of the all-welded bridge at Hasselt.* A good deal of information came to light in this connection, both by personal inspection and by reports published on the probable causes of those failures. A testing programme had been prepared, with series of tests dealing with some aspects of welding procedure on the rigid frames under construction. The programme included, among others, the following series :—

(1) Tensile tests : These were carried out both for parent metal and weld metal. These tests and most of the others were mainly related to the 1¼-in. thick plates which formed the flanges for the main portals, where the butt welds had to develop the full strength of the plate. Test pieces were turned to exact dimension from strips cut longitudinally or transversely to the butt weld, as shown in Figs. 46 to 49, page 322, complying, as far as possible, with British standards.*

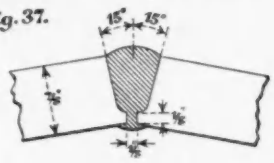
(2) Izod tests : These were carried out to ascertain the resistance of the parent metal and the weld metal to the notch effect under impact. Square bars of 10 mm. by 10 mm. cross section, with a triangular notch across one face, as shown in Figs. 50 and 51, page 322, were tested by measuring the energy required to fracture the restrained bar by blows at the free end. Average figures for parent-metal specimens were 41 ft.-lb., while weld-metal specimens required 53 ft.-lb., which is a far better value than that of 30 ft.-lb. required by B.S.S. No. 538.

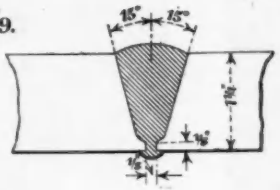
(3) Bending tests on longitudinal welds : In addition to the standard tests for bending of butt-welded test pieces, two series of tests were made with specimens as shown in Figs. 52 to 54, page 322. It is known that the welding of a light run on a plate of comparatively high thermal capacity may lead to hardening and even to brittleness due to sudden cooling of the molten metal. In view of the light fillet welds connecting the ⅜-in. thick web to the 1¼-in. thick flanges of the main portals, these tests were of some importance. Test plates were provided with a longitudinal notch of triangular section which was filled by weld metal and machined flush afterwards. A single run with 4-gauge electrodes (5·9 mm. diameter) was used for the 1¼-in. plate. The bending capacity was found to be considerably reduced ; in case of thin welds on thick plates caution is necessary.

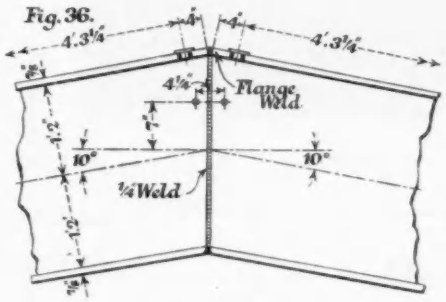
(4) Tensometer tests during welding : It was not intended to investigate stress distribution in the rigid portal corners, nor to check the calculated portal stresses by strain measurements under load. The purpose of the tests, however, was to get some information about the magnitude of stresses in the rigid frame introduced by the welding process only. Publications from various sources suggested considerable welding stresses, even up to 12·7 tons per square inch,† but it was claimed that redistribution of stresses would take place under service conditions. Twelve Huggenberger tensometers, Type B, were used to carry out strain measurements during welding. These instruments have a lever ratio of about 1,000 and a gauge length of 1 in. Various arrangements of instruments were tried out during welding in the workshop, and also with welding on site more than 40 ft. above the floor. Figs. 57 to 59, page 323, show the positions of 11 tensometers fixed to one flange of the main portal, at 6 in. from the centre line of the butt weld. The tensometers are marked *a* to *g* and *h*, *j*, *k*, *l*. A photograph taken during the test is reproduced in Fig. 55, the butt welding of the 1¼-in. flange taking place at a distance of only 6 in. from the instruments, which are protected by steel plates against heat radiation. In Fig. 56, a similar arrangement of tensometers is shown, with the 1¼-in. thick flange in the horizontal position and with the web vertical.

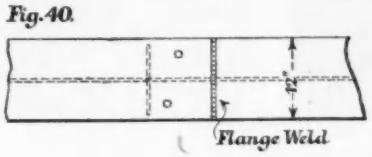
Another arrangement is indicated in Figs. 60 to 62. In this case, twelve instruments were clamped near one of the critical sections of the main portal during site welding of joint "W," Fig. 60. The actual welding took 3½ hours, the cooling time was 2½ hours, and readings were taken at regular intervals over 5½ hours. It was found possible to protect the instruments against direct radiation from the welding heat, but the flange plate itself, at such proximity to the butt weld, showed, of course, considerable changes of temperature during welding and cooling. Readings taken from the tensometers during that period were not interpreted as an indication of welding stresses. Final readings after return to normal temperature were, however, of great value in determining the proportion of additional stresses due to welding, indicating also the direction for further tests with welded rigid-frame structures.

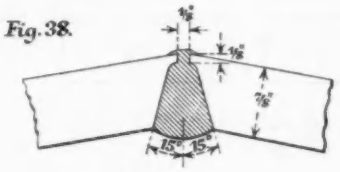
Erection.—The erection of the steel structure

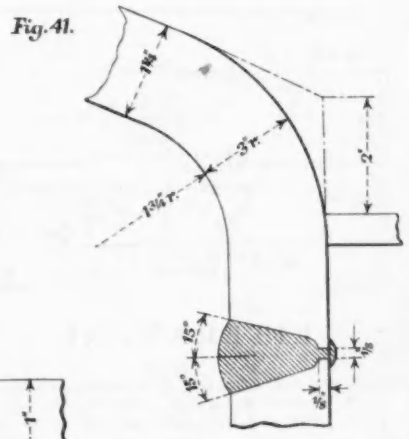


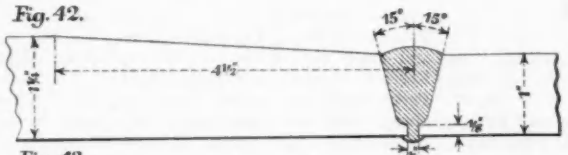


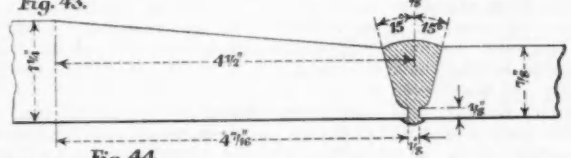


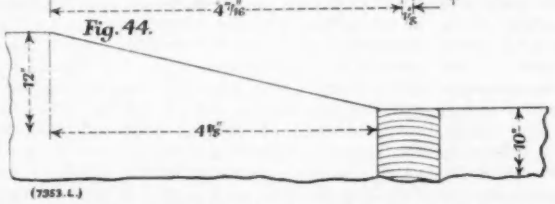


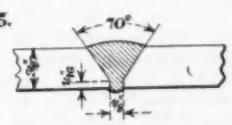












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* ENGINEERING, vol. 145, page 669 (1938).

* British Standard Specification No. 538. Metal Arc-Welding as Applied to Steel Structures.

† G. Schaper. Final Report, 1938, pp. 279-290. International Association for Bridge and Structural Engineering, Zürich.

had to be commenced at the far end, and part of the new building had to be completed before the welding equipment from the existing welding shop could be transferred into its new position. The demolition of the old welding shop could then be proceeded with and the site be cleared for completing foundations for the remainder of the new building. The first stage of the foundations at the far end is shown in Fig. 63, opposite. The new floor level is about 8 ft. below the ground. The main portals were erected in three parts each; a leg portion, before being hoisted, is shown in Fig. 64, on Plate XXIII. Fig. 65 shows a number of the main portals erected; the centre portion of one of the portals, it will be seen, is being hoisted into position. The base plates of the legs were bolted down by a special device to provide restraint during erection. After completion, hinge action was restored by cutting away outer strips of the base plates. Fig. 70, on page 330, shows a brake portal, connecting two of the main portals into a very rigid unit. Fig. 66, Plate XXIII, shows seven of the 16 portals erected, and the gantry girders and purlins assembled over 4 and 5 bays, respectively. Fig. 67 shows one of the gable-end wind girders, of 80 ft. 3 in. span and 4 ft. deep, after assembly and welding on site, with brackets welded to the web for supporting the gable stanchions.

Various views of the completed structure are given in Figs. 68 and 69, on Plate XXIII, and Figs.

TABLE V.

Building.	Steel.	Volume of Building.	Steel per Unit Volume.		Remarks
	Tons.	Cub. yd.	Lb. per cub. yd.	Per cent.	
German Building ..	430	39,000	24·8	100	One crane load of 15 tons.
,, ,,	364	39,000	21·1	85	
New building (calculated)	283	41,200	15·4	62	Two Crane loads of 20 tons.

71 to 73, on page 330. Fig. 71 shows the wind portal in the end bay, for transmitting horizontal reaction from the wind bracing in the roof to the gantry girder. The horizontal gantry bracing, consisting of tubes, will be noted. Fig. 72 shows the base of a main portal with a pin joint allowing free movement in the plane of the portal, and in Fig. 73 the bottom part of another main portal can be seen, with the brake portal joining at right angles. Spherical bearings are provided at these points allowing the leg to turn in any vertical plane. Bedplates for these bearings were built-up from mild-steel plates by flame cutting and welding. No castings were necessary. An illustration of the interior of the shop is given in Fig. 68, on Plate XXIII, and an outside view of the complete building in Fig. 69 on the same Plate.

Part of the new structure was put into service in 1938 and the building was completed in 1939. The calculated weight of steel was 283 tons. Regarding the economy of the new building, it is not easy to collect data for comparison of welded structures of similar type, dimensions and crane loads. It was possible, however, to find figures relating to two all-welded factory buildings recently erected in Germany. These structures have been regarded as examples of steel economy, and although their crane load is only 15 tons against 2 by 20 tons in the building described, the figures for steel tonnage for the new structure here dealt with compare very favourably with them. The comparison is given in Table V.

The building was designed by the author in close collaboration with the owners, to whom his thanks are due for permission to publish this article. The construction was carried out by the owners. Thanks are also due to Messrs. The Quasi Arc Company, Limited, Bilston, Staffs, who supplied the welding electrodes for providing some of the photographs included in this article.

WELDED RIGID-FRAME BUILDING.

Fig. 46.

Fig. 47.

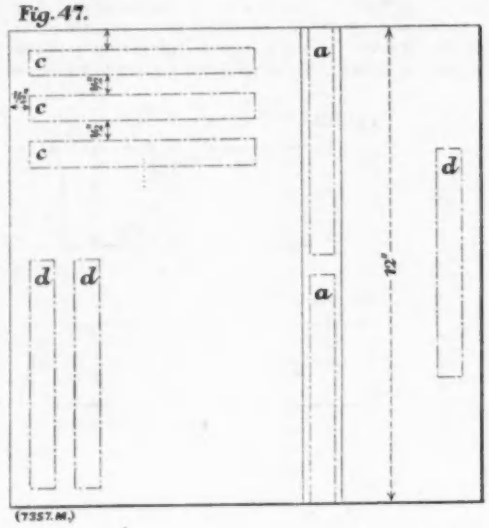

Fig. 48.

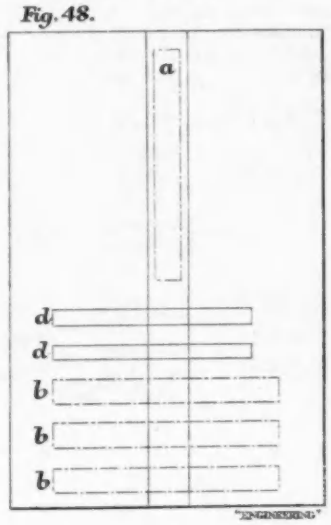

Fig. 49.

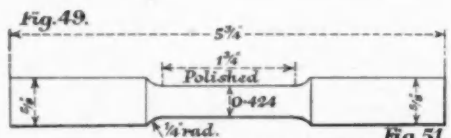

Fig. 50.

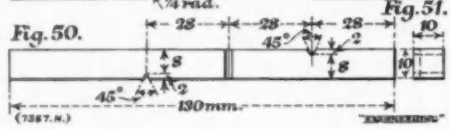

Fig. 51.

Fig. 52.

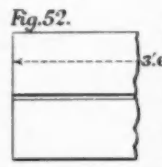

Fig. 53.

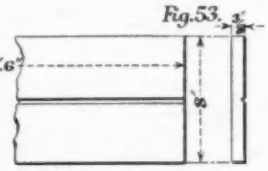

Fig. 54. DETAIL OF NOTCH

LITERATURE.

The Health and Efficiency of Munition Workers. By H. M. Vernon, M.A., M.D. Oxford: The University Press. London: Humphrey Milford. [Price 8*s.* 6*d.*]

The relation between hours of work and output is at all times a matter of industrial importance, but present conditions have given it the status of a major war problem. It has already received attention in these columns more than once and we have criticised some aspects of a pamphlet entitled *Industrial Health in Wartime*, recently published by the Industrial Health Research Board.* Although, at present, production is the main consideration, it is an undue simplification of the problem to be faced to regard it as embraced within the terms "hours of work" and "output." There is no simple relation between these two premises, and the question which has to be met is better expressed in the title of Dr. Vernon's new volume. Hours of work are necessarily closely related to industrial health and the problem with which the works manager has to deal is what arrangement of shifts, rest periods, canteen facilities, factory lighting, heating, etc., will produce the maximum output from his plant.

In an article which appeared in our issue of August 2, page 94, Dr. Vernon stated his case for moderation in the length of the working week and advanced evidence to show that shorter shifts, coupled with proper conditions of employment, could result in better outputs than are obtainable by excessively long working hours. In the present volume, he is able to deal with the matter in greater detail. He adduces much evidence, mainly derived from the experience of the war of 1914-1918, concerning the relative output-efficiency of various lengths and arrangements of shifts and relates this to questions of sickness and absenteeism, accidents, heating and ventilation, and welfare generally. His book is a valuable and clearly-stated résumé of the work on industrial health initiated by the Health of Munition Workers Committee during the last war, and since carried on by The Industrial Health Research Board, the National Institute of Industrial Psychology, and others. He expresses himself always with moderation and his volume forms a trustworthy guide among a mass of reports and blue books which bear directly on the activities of those concerned with the operation of factories, but which works managers at the present time have no opportunity of reading, or, in many cases, even of obtaining.

In our earlier discussion of this subject we criticised certain assertions concerning the increase in production obtained by reducing hours which appeared in the Industrial Health Research Board's pamphlet, and in our issue of July 26, page 77, there will be found a letter from Dr. Vernon defending the evidence appearing in that publication, but pointing out that it is misleading. Our difference from Dr. Vernon, if difference there is, concerns not the validity of his contentions but the extent to which they may be acted on in a time of vital emergency such as the present. He points out that in May of this year the Minister of Supply "instructed all Royal Ordnance and contractors' works to work full time for seven days a week until further notice." In our opinion, this instruction was entirely justified. Dr. Vernon, however, goes on to say "fortunately, the evils of long hours were soon realised." Control was transferred to the Ministry of Labour and "it is stated that the Government has agreed that the hours should be limited to 60 a week." Dr. Vernon does not say to what extent this "agreement" has been acted on, but certainly many skilled workers are still very far from reaching this ideal and the holiday breaks which were announced as a feature of this reduction of excessive hours are still a promise of the future. The improved output which may follow the introduction of shorter hours may well take two or three months to attain and those two or three months are not

* Engineering, vol. 149, page 505, and page 11, *ante*.

WELDED RIGID-FRAME FACTORY BUILDING.

(*For Description, see page* 321.)

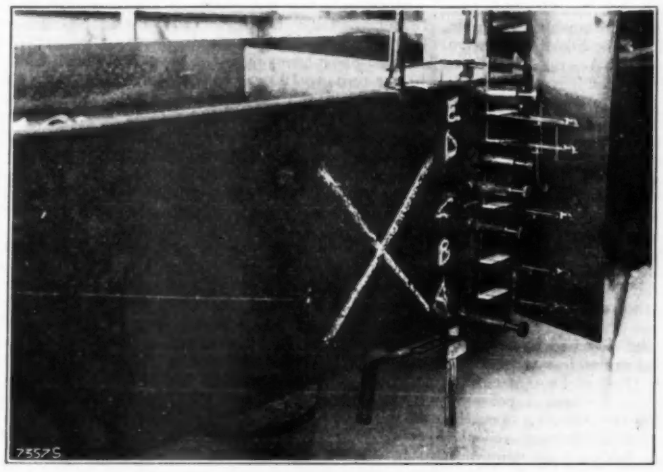

FIG. 55. TENSOMETER TEST ON VERTICAL FLANGE.

FIG. 56. TENSOMETER TEST ON HORIZONTAL FLANGE.

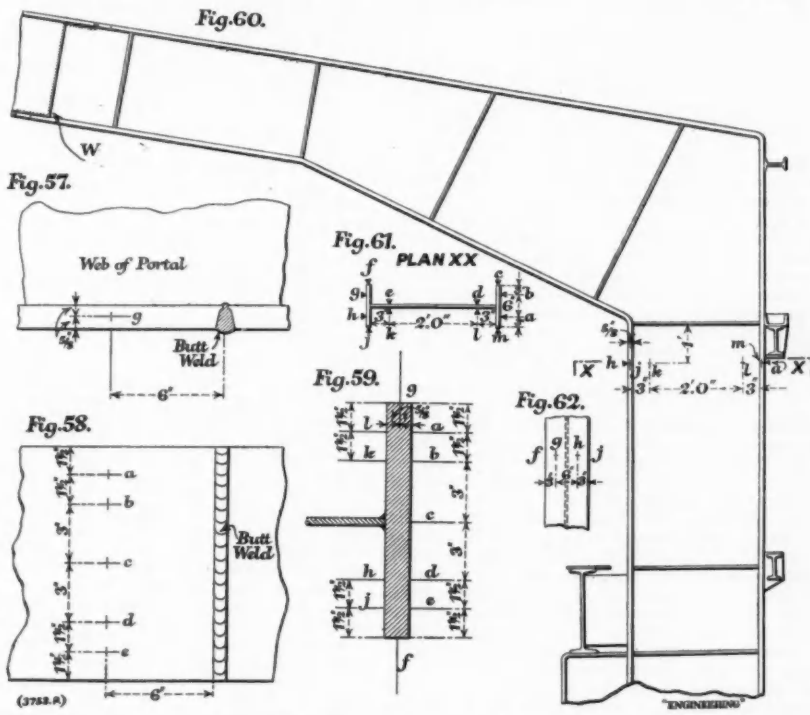

FIG. 63. FOUNDATION FOR SIDE WALL.

now available. Certainly, as the supply of trained workers gradually increases, steps will be taken in the direction of the shorter weeks for which Dr. Vernon pleads, and his volume will form a valuable guide to all industrial managers who have the grave responsibility of balancing the demands of the supply services against the well-being of their work-people.

Hydraulic Measurements: A Manual for Engineers. By PROFESSOR HERBERT ADDISON. London: Chapman and Hall, Limited. [Price 21*s.*]

THE author of this book is Professor of Hydraulics at the Fuad I University at Giza, very close to the oldest recorded canal work in the world, at Memphis. It is appropriate that Egypt, the motherland of hydraulic engineering, should be the place in which a book is written which is wholly devoted to the measurement of liquid flow. Although many technical papers have been produced on the subject, and all hydraulic text-books include discussions of it, there is apparently no treatise covering it fully and this work will meet an apparent need. The measurement of liquid discharge has been of paramount importance since the remote beginning of irrigation. With the development of the supply of potable water and the use of large-scale water power, the necessity for accuracy has grown, while in recent years the possibilities of economy of water or water power have caused intense effort to be applied to the development of precise and, if possible, rapid methods of measurement. Again, in the control of rivers, there has been a growing need for better means of gauging discharge in order to provide a basis for the design of works of regulation or impounding. At the other end of the scale is the measurement of small quantities of fluid in laboratory work, and then there is the dimensional inter-relation of measurement at these two extremes.

Professor Addison opens his book with a discussion of units and proceeds to describe the various methods of direct measurement of depth, head and pressure. Rather curiously, on page 6, he shows the various forms of Nilometer without naming them as such. A reference to Borchardt's classical paper on Nilometers would have provided an interesting historical note. His discussion of manometers is unusually full. He next deals with the subject of indirect indication and the transmission of pressure, head or depth readings. Perhaps a little more might have been said regarding the reliability and accuracy of the various systems; thus, in referring to the step-by-step system, nothing is said of the difficulties which occur with the reversal of motion and the bad effect of a missing step in vitiating all the subsequent record. Some useful notes appear in Chapter III on the installation and operation of pressure and depth gauges, after which follows a consideration of measurements of weight and volume and methods of switching. The subject of velocity is dealt with in Chapter V and very full consideration is given to the Pitot tube and its varieties. There is an excellent summary of practical matters concerning current meters.

The remaining chapters are all devoted to the question of discharge measurements. Chapter VI deals with free-flow apparatus, *i.e.*, tanks, screens travelling with the stream, orifice tanks and weir tanks. The next two chapters deal with meters: firstly, the quantity type and, secondly, those which show the rate of flow. Every known type appears to be referred to, in most cases, quite adequately and fairly. Chapter IX deals with special methods of measurement in closed pipes,

including, among others, the salt-velocity and Gibson inertia systems mentioned on page 179, *ante*. Discharge in open streams is the subject of the next three chapters. Floats, meters, Pitot tubes, chemical dosing, and the uses of slope and stage records are well considered. Weirs and flumes, including, of course, the throated types, follow thereafter. Chapter XII is devoted to the subject of regulating sluices as instruments of measurement, and to the interpretation of model results on the same devices. The last chapter deals with indicating, recording and integrating instruments for flow-measuring installations. A glossary of technical terms and a bibliography are among the appendices to this useful and interesting book.

Principles of Mineral Dressing. By A. M. Gaudin. London: McGraw-Hill Publishing Company, Limited. [Price 33*s*.]

The possibility of exploiting extensive deposits of ores economically often depends upon the suitability of the methods adopted for dressing the ore, so that the importance of a correct appreciation of the available methods and processes, especially at the present time, requires no emphasis. The subject, as dealt with in the volume under review, embraces not only ore-dressing but includes other minerals, such as coal, which do not come within the definition of ores. In view of the modern tendency for specialisation and the fact that numerous works have been published in recent years which deal exclusively with such subjects as coal cleaning, the publication of a single volume which covers all classes of minerals may be regarded by some with disapproval; but, as the author explains in his preface, the book is the outcome of a series of lecture notes designed primarily for the use of senior students of chemical, geological, metallurgical and mining engineering. He expresses the opinion that there is no fundamental difference between the dressing of any of the ores or minerals, and, consequently, that there is no such thing as coal dressing as an art distinct from the milling of gold or copper ore.

In view of the great changes which have taken place, not only in machinery but also by the introduction of fundamentally new methods in ore dressing during the past two or three decades, a treatise which must be up-to-date and yet kept within limited dimensions is liable to deal inadequately with the older methods. Some sort of compromise is obviously unavoidable, and in this the author shows admirable discrimination. A commendable balance is maintained in the relative treatment of theory and practice. Since the movement of solids in fluids provides the basis of nearly all mineral-dressing processes, a thorough grasp of the theory of this subject is a prime essential. It is satisfactory to find that an entire chapter has been devoted to this fundamental study. The chapter on "Classification" deals adequately with both the theoretical and practical aspects of this important operation and is illustrated with photographs and drawings of various types of classifiers, including both those which effect merely a sizing operation and those which serve as a means of concentration, such as the Dorr washer or the Rheolaveur trough washer.

Separate chapters are devoted to "Jigging" and "Flowing-film Concentration and Tabling." Vanners, buddles and round tables are now practically obsolete, except in the recovery of cassiterite ranging in size from 0·01 mm. to 0·06 mm., because they fail to recover particles finer than 10 microns to 20 microns. A large part of the valuable minerals in the slimes is not recovered by shaking tables, but can be recovered by flotation. The relative importance of flotation methods at the present day is accurately reflected by the devotion of four chapters to this branch of ore-dressing. The lucid explanation of the basic principles involved should prove particularly useful to the students for whom the book is primarily intended. Only a few of the more important sections of the book have been commented upon, but the other important processes of mineral dressing have not been neglected by the author. A valuable feature of the book is the comprehensive bibliography provided at the end of each chapter.

THE MANUFACTURE OF STEEL BY THE PERRIN PROCESS.*

By B. Yaneske.

In October, 1935, the author, accompanied by Mr. J. J. Ghandy, general manager of Messrs. The Tata Iron and Steel Company, Limited, Jamshedpur, India, visited the electric steel works of the Société d'Electro-Chimie, d'Electro-Métallurgie et des Aciéries Electriques d'Ugine, France, for the purpose of investigating the possibility of operating at the Tata Works the steel-making process invented by Mr. R. M. V. Perrin, director of the above-mentioned French company. Mr. Perrin explained that his process, which was patented in all steel-making countries, consisted of the treatment of molten steel by pouring it from a considerable height, say, about 20 ft., into a previously prepared synthetic slag contained in the casting ladle, or by other means churning the steel and slag together before casting the steel into ingots. Mr. Perrin stated that his process could be used either for deoxidising or dephosphorising molten steel, by varying the composition of the synthetic slag.

For deoxidising purposes, the slag had to be highly silicious, the silica content being not less than 55 per cent., and the iron oxide ($FeO + Fe_2O_3$) content as low as possible, preferably not above 1 per cent. Mr. Perrin claimed that during the churning operation oxygen in the form of ferrous oxide was absorbed by the slag from the steel, *i.e.*, the steel was deoxidised not in the usual way, by the addition of deoxidisers which gave rise to solid inclusions, but by the actual removal of the ferrous oxide in accordance with the following equation:—

$$2FeO + SiO_2 = Fe_2SiO_4.$$

At the same time, silicon also entered the steel by reduction of silica from the slag. Therefore, the result was that the deoxidised steel was free from non-metallic inclusions, since no inclusions could be formed in the process, this assertion being supported by practical results. Mr. Perrin stated that about 3 per cent. of synthetic slag was sufficient to obtain a satisfactory degree of deoxidation.

For dephosphorising purposes, a highly basic oxidising slag was necessary, the lime content being preferably above 55 per cent., and the iron oxide ($FeO + Fe_2O_3$) content not less than 25 per cent. Mr. Perrin claimed that when molten steel was churned with this molten synthetic slag, the phosphorus in the steel was oxidised to phosphoric acid, which combined with the lime in the slag to form calcium phosphate according to the following equation:—

$$3CaO + P_2O_5 = Ca_3(PO_4)_2,$$

the calcium phosphate being retained in the slag. Thus there was a considerable increase in the P_2O_5 content of the slag, with the resultant possibility of utilising the finished slag as an artificial fertiliser, if the percentage of phosphorus to be removed from the steel was sufficient. Mr. Perrin stated that after the churning operation there was a remarkable decrease in the total iron oxide content of the slag, which was sometimes diminished from 35 per cent. to as low as 6 per cent. or 7 per cent., iron thus being reduced from the slag to the steel and so increasing the yield. Mr. Perrin also claimed that he had found the dephosphorisation to be very intensive, even when starting from a low initial phosphorus content, and that the exothermic dephosphorising reaction which occurred in the ladle was completed in less than one minute for 15 tons of steel. With reference to the quantity of synthetic slag required, Mr. Perrin stated that it might vary from 5 per cent. to 15 per cent. of the weight of steel, depending on the percentage of phosphorus to be removed from the steel, and also on the pouring height or the intensity of the churning of the steel and slag together.

As Mr. Ghandy and the author had in view the economic application of Mr. Perrin's process for the manufacture of low-carbon steels directly from Tata blast-furnace iron containing 0·28 per cent. to 0·40 per cent. of phosphorus, after blowing it in an acid Bessemer converter, thus eliminating the basic open-hearth furnace for finishing the blown metal, they were more interested in the dephosphorising process. It was therefore arranged with Mr. Perrin that two experiments in dephosphorisation should be carried out at the Ugine steelworks in their presence.

Dephosphorising Experiment with Very Low Percentage of Manganese in the Steel.—The object of this experiment was to dephosphorise in the ladle to below 0·05 per cent. of phosphorus, steel which was low in carbon, manganese and silicon, but contained about 0·30 per cent. of phosphorus. This composition would, therefore, be similar to that of the Bessemer soft blows at the duplex plant of the Tata Iron and Steel Works at Jamshedpur, where the duplex process is operated by blowing iron in a 25-ton acid Bessemer converter and then transferring the blown metal to a 250-ton basic open-hearth tilting furnace to dephosphorise and finish the steel to the required chemical specification.* The experiment would, therefore, demonstrate the possibility of dephosphorising Tata Bessemer-blown metal by the Perrin process. Mr. Perrin stated that, in order to remove about 0·275 per cent. of phosphorus from the steel, he considered about 10 per cent. to 12 per cent. of synthetic slag would be necessary in the experiment, but this amount could be reduced to about 7 per cent. by well shaking the steel and slag together, or by pouring the steel into the slag from a height of not less than 20 ft. Mr. Perrin was of the opinion that by using only 7 per cent. of slag it would be possible to obtain about 10 per cent. of P_2O_5 in the slag after the mixing operation.

A synthetic basic slag was prepared in a 5-ton Girod-Héroult basic-lined electric-arc furnace. The slag consisted of a mixture of lime, iron ore and a little fluorspar. In order to start making the slag, 2,500 kg. (2½ tons) of Armco iron were charged into the empty furnace in order to make the necessary electrical circuit. On the top of this iron, the following ingredients for making the slag were charged, namely, lime (CaO 85 per cent.), 1,400 kg (28 cwt.); iron ore (FeO 65 per cent.), 800 kg. (16 cwt.); fluorspar (CaF_2 85 per cent.), 175 kg. (3½ cwt.). Mr. Perrin was aiming at the following composition of the slag, with which he previously had obtained very good results, namely, CaO, 60 per cent.; $FeO + Fe_2O_3$, 30 per cent.; SiO_2, Al_2O_3, MgO, etc., 10 per cent.

In an adjacent 15-ton Girod-Héroult basic-lined electric-arc furnace, a charge consisting of 12,000 kg. of plain carbon-steel bloom butts and broken rails was melted with 1,000 kg. of calcined lime. After the bath was clear melted, the slag was poured off. The following is a record of the heat from this stage:

Heat No. 92,440. *October* 8, 1935.

	P.M.
First slag poured off	3·25–3·28
Lime added to clean bath, 200 kg. (4 cwt.) ...	3·30
All slag raked off	3·40–3·48
Ferro-phosphorus added, P 24 per cent., Si 5 per cent., 150 kg. (3 cwt.)	3·50
Sample of steel	3·53
Furnace tapped (steel poured into slag) ...	3·54
Slag Furnace.	
Sample of slag	3·43
Slag tapped into casting ladle, 2,000 kg. (2 tons)	3·51

The pouring height from the furnace launder to the bottom of the casting ladle was approximately 14½ ft., and there was no visible reaction in the ladle when the steel was poured into the slag. The firebrick lining of the ladle and the stopper were coated with magnesia cement. The treated steel was cast through a 40-mm. (1⅝-in.) diameter nozzle into open wide-end up moulds, eight ingots of 1,600 kg. (32 cwt.) each being cast. After teeming, there was a skull weighing about 500 kg. left in the ladle bottom. A sample of steel was taken for analysis after casting the fourth ingot, and a sample of slag immediately after all the steel was cast. The quantity of aluminium added in the moulds was 2 kg. (4·4 lb.) to the first two ingots, which rose in the moulds, and 2½ kg. (5·5 lb.) to the other six ingots, which had flat tops. The analyses of the steel and slag samples are given in Tables I and II, opposite.

Notes on the Experiment.—The phosphorus content of the steel before dephosphorising was found on analysis to be only 0·252 per cent. and not 0·30 per cent. as desired for the experiment. The phosphorus in the treated steel was 0·066 per cent. and, therefore, was not reduced below 0·050 per cent. as desired. The weight of the synthetic slag used was 15 per cent. of that of the steel plus the ladle skull, and was therefore much in excess of the amount regarded as necessary to effect the desired dephosphorisation. Although phosphorus had been removed to the extent of 0·186 per cent. (from 0·252 per cent. to 0·066 per cent.), the P_2O_5 content of the slag after mixing was only 2·03 per cent., mainly due to the large percentage of dephosphorising slag used. The weight of ingots made was 12,800 kg. (12 tons 16 cwt.), whereas the total metallic charge was 12,150 kg. (12 tons 3 cwt.). Therefore, there was a gain of 650 kg. (13 cwt.), which can only be accounted for by some of the melted Armco iron from the slag furnace having been poured into the casting ladle with the synthetic slag. The CaO in the synthetic dephosphorising slag was only about 47 per cent. instead of 60 per cent., as desired. It was evident that the low lime content and high iron-oxide

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* Paper submitted to the Iron and Steel Institute and circulated for written discussion. Abridged.

* The duplex process as operated in India at the works of The Tata Iron and Steel Company has been described by the author in a paper published in the *Journal of the Iron and Steel Institute*, No. I, page 181 (1927).

content of the slag were brought about by dilution with some oxidised Armco iron charged in the slag furnace. There was very little decrease in the total iron-oxide content of the slag after mixing, which was contrary to expectation. The treated steel was highly oxidised, as was evident from the fact that as much as 3·44 lb. per ton of aluminium was required to kill the steel in the moulds.

Dephosphorising Experiments with 0·40 Per Cent. of Manganese in the Steel.—An experiment in the presence of so much manganese had never been attempted before by Mr. Perrin. As there was every possibility of the manganese being oxidised along with the phosphorus during the mixing of the steel and slag, if a slag of composition similar to that in the previous experiment were used, it was agreed that an addition of about 10 per cent. of MnO should be made to the slag for the present experiment, with the object of minimising the oxidation of manganese from the steel. As in the previous experiment, ferro-phosphorus would be added to yield about 0·30 per cent. of phosphorus in the steel, but, in addition, ferro-manganese would be added to yield about 0·40 per cent. of manganese. The object of this experiment was to ascertain whether it would be possible to make low-carbon steels directly from the acid Bessemer converter by blowing the carbon out of Tata blast-furnace iron until only about 0·10 per cent. remained, adding the required amount of ferro-manganese in the converter, and then removing

TABLE I.—*Analysis of Steel.*

Element.	Before Mixing.	After Mixing.
C, per cent.	0·04	0·05
Mn, ,, ...	0·04	0·03
S, ,, ...	0·013	0·013
P, ,, ...	0·252	0·066
Si, ,, ...	0·005	0·002

TABLE II.—*Analysis of Slag.*

Constituent.	Before Mixing.	After Mixing.
SiO_2, per cent.	4·75	5·36
Al_2O_3 ,, ...	1·36	1·28
FeO, ,, ...	25·80	29·96
Fe_2O_3 ,, ...	16·02	8·54
MnO, ,, ...	1·74	1·79
CaO, ,, ...	46·98	46·95
MgO, ,, ...	2·48	3·60
P_2O_5, ,, ...	0·19	2·03
TiO_2, ,, ...	Traces	Traces
S, ,, ...	0·045	0·053

the phosphorus by pouring the blown metal containing manganese into a previously prepared synthetic slag.

As in the previous experiment, the phosphorus content of the steel before mixing with the slag was found, on analysis, to be low, being 0·253 per cent. against 0·30 per cent. desired. The phosphorus in the treated metal was 0·076 per cent. and, therefore, was not reduced below 0·050 per cent. as desired. The weight of synthetic slag used was nearly 13 per cent. of the weight of steel plus the ladle skull. Although phosphorus had been removed to the extent of 0·177 per cent. (from 0·252 per cent. to 0·066 per cent.), the P_2O_5 content of the slag after mixing was only 2·38 per cent., mainly owing to the large percentage of dephosphorising slag used. The presence of more than 10 per cent. of MnO in the slag did not prevent the oxidation of some of the manganese, which was reduced from 0·42 per cent. to 0·26 per cent. during the dephosphorising reaction. The weight of ingots made was 15,400 kg. (15 tons 8 cwt.), whereas the total metallic weight charged was 12,208 kg. (12 tons 4 cwt.). Therefore, there was a gain of about 3,200 kg. (3 tons 4 cwt.), so that it is certain that the whole of the Armco iron and manganese-steel scrap was melted and tapped into the casting ladle along with the dephosphorising slag, The CaO in the synthetic slag was 51·65 per cent., which was more than in the previous experiment, but still lower than desired. This was evidently due to dilution with some oxidised Armco iron and manganese-steel scrap charged in the slag furnace. As in the former experiment, there was very little reduction in the total iron content of the slag after mixing. The treated steel was highly oxidised, as indicated by the large additions of aluminium (2·75 lb. per ton) plus silicon-aluminium alloy (3·44 lb. per ton) which were required to kill the steel in the moulds.

Although the two foregoing experiments in dephosphorisation carried out at the Ugine steelworks were only partly successful and left much to be desired, they were considered by Mr. Ghandy and the author to be sufficiently encouraging to justify the conducting of further experiments at the Tata Works in India. The result was that, on the author's return to India, an exhaustive series of experiments was carried out under his supervision at the Tata duplex plant, as circumstances permitted. In all, one hundred experiments were conducted, of which particulars of a selection are given below.

In order to conduct these experiments, one of the 250-ton basic open-hearth tilting furnaces at the duplex plant was employed for melting the synthetic dephosphorising slag whenever suitable opportunities occurred. It was decided that the experiments, to commence with, would be conducted on similar lines to those carried out at the Ugine steelworks. Therefore, blast-furnace iron taken from the hot-metal mixer would be blown in an acid Bessemer converter, after which the blown metal would be poured into a quantity of synthetic molten slag in the casting ladle, and the resultant dephosphorised steel cast into ingots.

Owing to a difference in gauges of the overhead ladle cranes in the Bessemer shop and the open-hearth pitside, and the pouring height from the Bessemer converters being insufficient, it was not possible to carry out the experiments without reladling the blown metal. Therefore, it was necessary to provide a firebrick-lined pouring trough leading from the furnace platform to the pitside, so that blown metal could be poured down the trough into the dephosphorising slag contained in a pitside casting ladle, which was being held on the hooks of one of the pitside ladle cranes. The height of the trough from the bottom of the casting ladle was 21½ ft. This arrangement, of course, resulted in a loss of temperature of the blown metal, so that, to provide for this loss, a higher silicon content of the iron was essential than would be required in a new plant specially designed for operating the Perrin process, where reladling would be totally unnecessary. It was also necessary to use ladles of 100-ton capacity in all the experiments, as smaller ladles were not available.

(To be continued.)

THE PORT OF LONDON.*

By ASA BINNS, M.I.Mech.E.

ON looking through the list of past-presidents, I find that I am the first whose career has been largely devoted to dock engineering. My workshop training, from 1893 to 1896, was almost entirely concerned with hydraulic plant for dock equipment, such as cranes, capstans, lifts, etc. In 1898 I had my first actual dock experience in Hull with the North Eastern Railway Company. This was followed by a few years in the Works Department of the Admiralty in London and at Chatham Dockyard; but for the past 34 years my work has been almost entirely connected with the Port of London. During the past forty years the average size of ships in the Mercantile Marine has increased enormously. The average tonnage of first-class cargo liners trading to the Port of London has more than doubled, while the length and beam of ships have been increased by something like 40 per cent., although the maximum draught has shown little increase beyond 34 ft., which had been attained at the beginning of the century. Whether it is judged by the volume of shipping entering its river, or by the value of the commodities discharged at its quays, London has long been the greatest port in the world. It was the principal port of the country, even before it became its capital city.

During the Roman occupation of Britain, London was the centre of all maritime activity. In Saxon times, trade developed, and the Danes used the port as a naval base during their occupation. Notwithstanding foreign and civil wars during the four hundred years following the Norman conquest, the trade of the port continued its progress. From the Thirteenh Century to the close of the reign of Elizabeth, the Hanseatic League did much to foster the trade of the port. During the Seventeenth and Eighteenth Centuries, congestion in the river became more and more pronounced and, between 1793 and 1799, a number of schemes for improving the accommodation engaged the attention of Parliament and the mercantile community. After long inquiry, a Committee of the House of Commons reported, in 1796, in favour of the construction of enclosed wet docks. As a result, the West India Docks were constructed and opened, in 1802, by William Pitt, then Prime Minister. Before that date, two small docks already existed on the Thames, one of which—the Howland Great Dock, built at Rotherhithe under an Act of 1696—was actually the first public wet dock in Great Britain. The other was the Brunswick Dock, constructed at Blackwall in 1789. Neither of these pioneer docks, however, provided any storage accommodation. The West India Docks were quickly followed by the London Docks at Wapping, opened in 1805, and by the East India Docks, opened in the following year. Meanwhile, the Howland Dock was acquired by the Commercial Dock Company, who carried out considerable extensions. The Grand Surrey Canal Company also constructed a basin and entrance lock from the river at Rotherhithe, and a canal leading therefrom to Camberwell and Peckham. These two undertakings, together with their various extensions, were amalgamated in 1865 under the name of the Surrey Commercial Dock Company.

The year 1828 saw the opening of the St. Katharine Dock, and in 1838 the East and West India Docks Companies were amalgamated. After a short lull, the Victoria Dock was constructed and opened for traffic in 1855. In 1864, the London Docks Company and the St. Katharine Dock Company amalgamated and purchased the undertaking of the Victoria Dock Company. Further competition came with the formation of the Millwall Dock Company, whose docks were opened in 1868. Subsequently, the London and St. Katharine Docks Company constructed an extension to the Victoria Dock which was named the Royal Albert Dock. This was opened in 1880, and provoked the East and West India Docks Company to reply with the construction of the Tilbury Docks, completed in 1886. It was evident that the keen competition between the different companies was leading to financial disaster, and, in 1888, a combination of the two main companies arrived at a working understanding which culminated, in 1901, in the amalgamation of the undertakings under the title of the London and India Docks Company. With the exception of the extension of the Greenland Dock, completed in 1904, no further works of major magnitude were carried out in the port until after the formation of the Port of London Authority.

The Port Authority's formation was the result of an investigation by a Royal Commission, set up in 1900. An Act was passed in 1908 which created the Authority and handed over to it the whole of the docks and the tidal portion of the river. There are twenty-eight members of the Authority, of whom eighteen are elected by the payers of dues, and the remaining ten are appointed by public bodies and Government Departments. The purchase price paid for the acquisition of the docks was about 23,000,000*l.*, and, in the course of the past thirty years, the Authority has spent about 20,000,000*l.* more in the improvement of the port. These improvements include the deepening and widening of the river channel, the construction of entirely new dock accommodation, deepening and widening of the older docks and entrances, and the provision of modern equipment. The improvements now in progress at the Royal Victoria Dock, which was opened 85 years ago, will make it one of the most useful docks in the port.

The largest individual piece of new work on which I have been closely engaged was the construction of the King George V Dock, on which I contributed a paper* to the Institution of Civil Engineers in 1923. I propose, however, to give now, for the purposes of record, a short description of this important work. It was commenced in 1912 and was opened by H.M. King George V and Queen Mary in 1921. The total cost was over 4,000,000*l.*

The entrance lock, Fig. 2, page 326, is 800 ft. long by 100 ft. wide, and is 45 ft. deep at Trinity High Water. It is divided into two compartments by three pairs of steel lock gates. The wet dock has an area of 64 acres, with 10,000 lineal ft. of quays, and provides 14 berths for steamers of the largest size. The dock is well equipped with transit sheds, those on the north side being double-storey, of reinforced-concrete construction, while on the south side are seven reinforced-concrete jetties, each 500 ft. long, affording special facilities for overside delivery to barges. One of these jetties is shown in Fig. 1, on page 326. The single-storey transit sheds on this quay are of steel and corrugated-iron construction. There is a dry dock, 750 ft. long, 100 ft. wide, with a depth of 35 ft. of water over the keel blocks, and there is also a communicating passage between the Royal Albert and the King George V Docks, 100 ft. wide, with a depth of 34 ft.

In the preparation of the contract particulars, a careful survey was made, including cross-sections at intervals of 100 ft. over the whole site; and a series of twenty-eight borings and two trial holes were sunk. The contract for the work was placed with Messrs. S. Pearson and Son, Limited, in August, 1912, one of the conditions being that the work should be completed in four years. The work was brought nearly to a standstill, however, by the war of 1914-18, and it was not until late in 1918 that the Government granted special facilities for its completion. The contract was then terminated by arrangement, and the Port Authority itself completed the work by direct administration. In the course of the excavations, several silted-up creeks cutting into the peat were encountered, the largest of these being the old Ham Creek, which was

* Presidential Address to the Institution of Mechanical Engineers: delivered in London on Friday, October 18, 1940. Abridged.

* *Proc. Inst. C.E.*, vol. 216, page 372 (1922-3).

navigable to ships in the Seventeenth Century. The new works were founded generally on ballast or chalk.

For carrying out the dock contract, electric power was supplied in bulk by West Ham Corporation, at a pressure of 6,600 volts, and this was suitably transformed and used for operating pumps, concrete mixers, etc. The whole of the work was carried out in the dry, pumping sumps being provided in suitable positions for discharging the water either into the river or into the Royal Albert Dock. A view of the Royal Albert Dock is shown in Fig. 3. For long periods, the total pumping averaged about 10,000 gallons per minute, with a maximum of 13,000 gallons per minute. The main excavation of the dock was carried out by means of Lubecker steam land dredgers, each weighing about 130 tons, with engines of 120 h.p. Under favourable conditions they were each capable of excavating about 2,000 cub. yds. a day. In addition, steam navvies were employed for excavation in special places, and especially at the entrance lock and the dry dock. About 17 miles of temporary railway were laid over the site, and 16 locomotives were employed to haul 600 wagons of various descriptions. The surplus excavation was dumped at sea, a distance of 60 miles, by means of hoppers which were loaded by two special tipping hoists in the Albert Dock. Of the total excavation of about 5,000,000 cub. yds., 2,000,000 cub. yds. were thus disposed of. Under the best conditions, the hoppers carried away about 30,000 cub. yds. a week.

The concrete mixers in general use for the mass concrete were of 1½-cub. yd. capacity, and were driven by 20-h.p. electric motors. More than 30 cranes were in use on the site, ranging from 5 tons to 10 tons capacity. Over 3,000 reinforced-concrete piles were made on site, in addition to other pre-moulded sections for the dock jetties, etc. The maximum number of men employed in carrying out the work on the site was 1,700. Over 100,000 tons of cement were used in making the half-million cub. yds. of concrete required; and over 250,000 cub. ft. of granite from Cornwall were used for copings, altars, cills, etc.

The dock is equipped with 66 electric quay cranes, of 3 tons capacity, for handling cargo. The electrically-driven pumps at the dry dock pumping station are capable of emptying the dry dock in three hours. Each of the two pumps requires 820 h.p. and discharges through a pipe 4 ft. 6 in. in diameter. The lock gates are of steel, and each leaf weighs 350 tons. Six air chambers are provided in each leaf to give the necessary buoyancy. The gates are operated by direct-acting hydraulic rams. The floating caisson, which is used for closing the entrance to the dry dock, weighs over 600 tons, exclusive of the permanent ballast. There are two moving bridges. The swing bridge over the passage is of the pivot type, 200 ft. long. The total swinging weight is about 1,800 tons, of which 850 tons are kentledge. It is operated by hydraulic power, and the complete operation of opening or closing is performed in 75 seconds. The bridge over the entrance lock is electrically-operated and is of the double-bascule type. Its weight is about 740 tons, including 360 tons kentledge.

During the past hundred and fifty years, barrage schemes with the avowed object of improving the Port of London have been proposed from time to time. Mr. Reveley put forward several projects in 1795 in opposition to the proposed wet docks; Mr. Henry Robinson put a proposal before the Institution of Civil Engineers in 1856; and, in 1903, a scheme was seriously discussed for a barrage at Gravesend. In 1934-35, a new proposal to install a barrage at Woolwich was seriously discussed in Parliament. A public inquiry was to have been held in 1938, but was abandoned at the last moment owing to the grave international situation then developing. As I was chief engineer of the Port Authority at the time, I studied the proposals closely, together with the data available regarding barrages constructed throughout the world. The opinion I formed as a result of these studies was that the proposed barrage would be disastrous to the Port of London.

Briefly, my objections are:—(*a*) The danger and inevitable delay in passing the whole traffic of the Thames through the locks in the barrage. (*b*) The interference with the tidal regime of the Thames, and its effect on dredging both above and below the barrage. (*c*) The effect on the public health of London by the impounding of the water above the barrage to the level of high water. Low-lying property would become uninhabitable, cellars and vaults would be flooded, and there would be unfortunate effects on adjacent tunnels, gas, water, and electric mains. During a period of summer drought, the Pool of London would become the "cesspool" of London. (*d*) The project would cost at least 8,000,000*l.*; traffic would be gravely inconvenienced during the period of construction; and the working costs of the barrage and attendant staff would put a heavy financial burden on the trade of the Port. (*e*) The barrage would be a source of weakness in war time, as it would be a target

THE PORT OF LONDON.

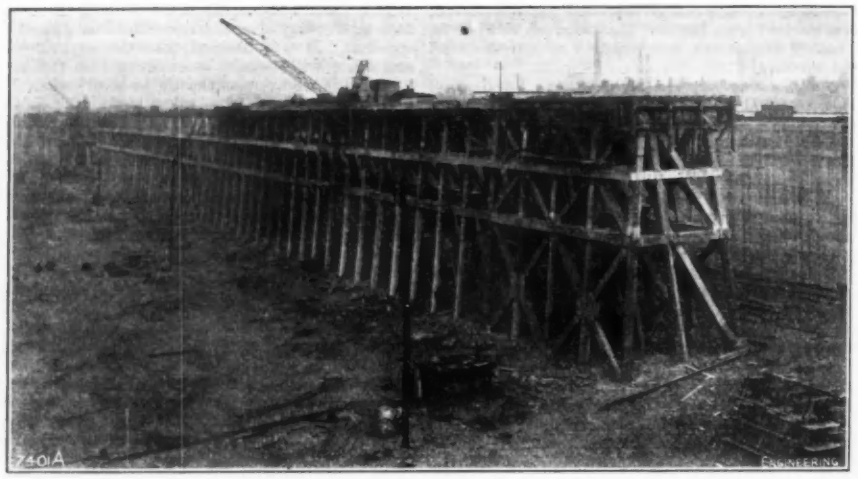

Fig. 1. Reinforced-Concrete Jetties, King George V Dock.

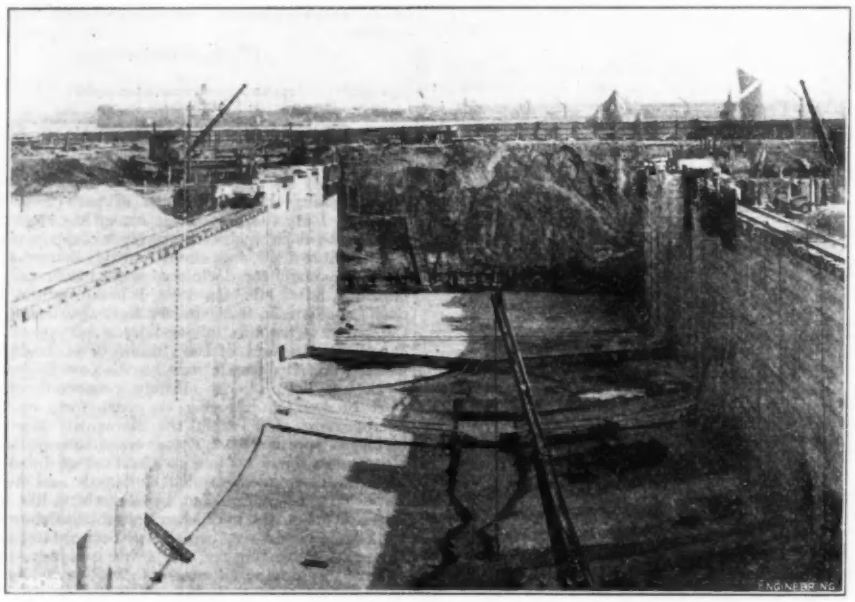

Fig. 2. Entrance Lock under Construction, King George V Dock.

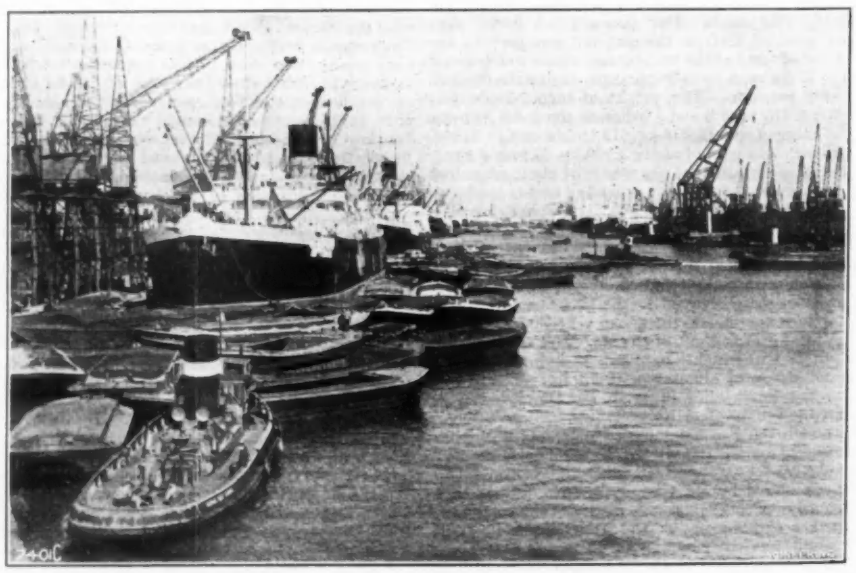

Fig. 3. Royal Albert Dock, Looking East.

THE PORT OF LONDON.

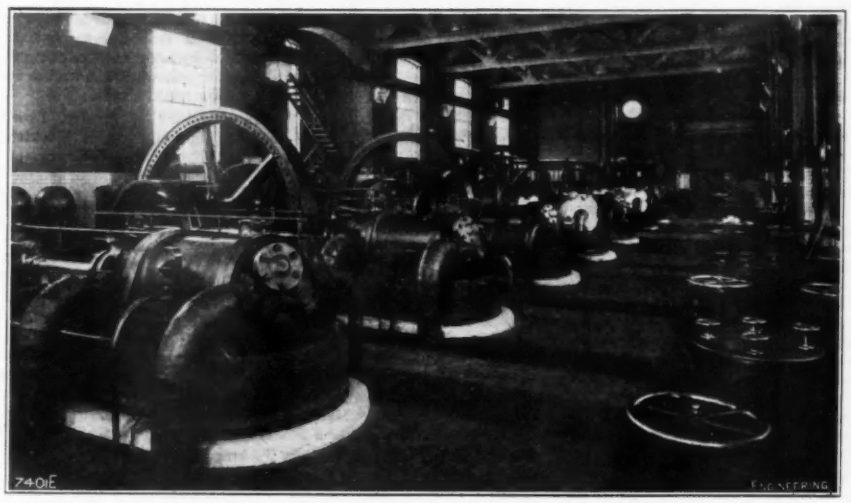

FIG. 4. REFRIGERATING STATION, ROYAL ALBERT DOCK.

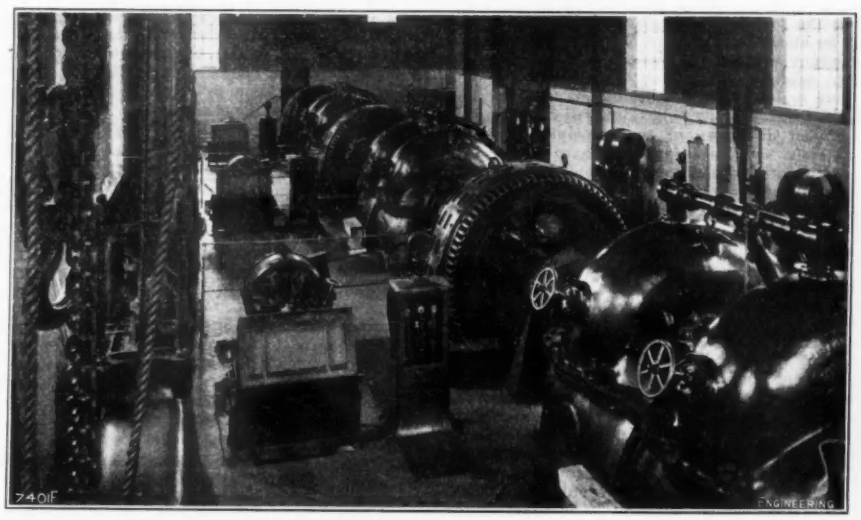

FIG. 5. GALLIONS IMPOUNDING STATION, ROYAL ALBERT DOCK.

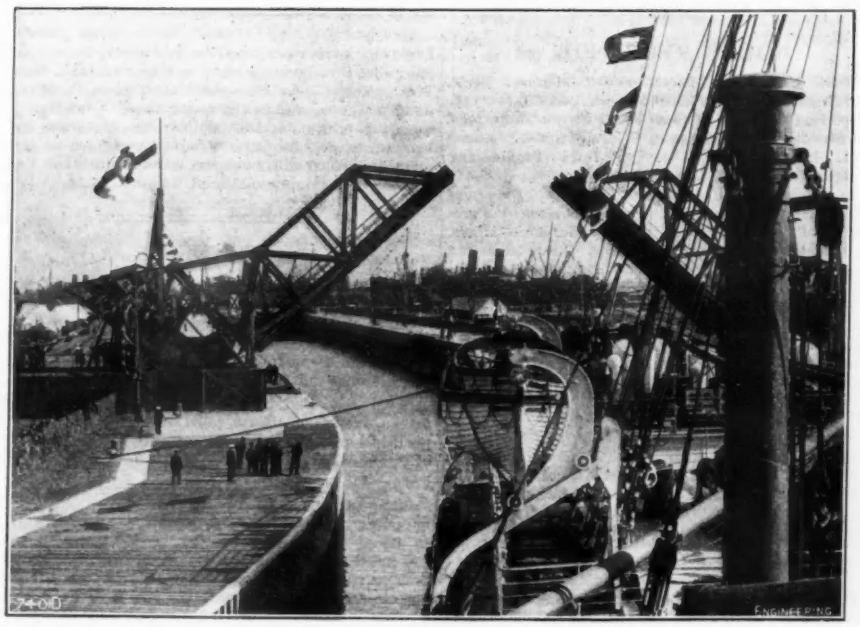

FIG. 6. TILBURY ENTRANCE LOCK.

for enemy aircraft and its destruction would paralyse the movement of shipping.

A great feature of the Port of London is the development of cold-storage accommodation. My first experience of refrigeration on a practical scale was at Hull in 1898, where an ammonia-absorption plant was in use at the foreign cattle depot, and an ammonia-compression plant was installed by Messrs. Sterne, of Glasgow, for the cold storage of frozen mutton. The London Docks were pioneers in the provision of cold-storage accommodation, their first store being opened at the Victoria Dock in 1881. In 1897, the late Sir H. F. Donaldson read a paper* before the Institution of Civil Engineers, entitled "Cold Storage at the London and India Docks." Since that date great progress has been made, and fine storage accommodation is now available in the Port for frozen and chilled meat, fish, bacon, dairy produce, and fruit. During the war of 1914-18, a new cold store was constructed at the Royal Albert Dock, with accommodation for half a million carcasses of mutton. In earlier days, the storage space was usually cooled by the circulation of cold brine, but in later installations cold air is circulated by means of suitable air ducts, and the use of charcoal and slag wool as insulating media has largely been superseded by the use of compressed slabs of granulated cork. Fig. 4, on this page, shows the interior of the refrigerating station at the Royal Albert Dock, and Fig. 5 shows the Gallions impounding station. A photograph of the entrance lock at Tilbury, showing the bascule bridge partly opened, is reproduced in Fig. 6.

Manual dock labour, from the power-producing point of view, is from 100 times to 200 times as expensive as mechanical power at the rates of pay prevailing in London. This disparity would appear to warrant almost unlimited mechanisation, but this is a fallacy. The dock labourer is flexible and can carry out all sorts of instructions, and is, in fact, highly skilled in many directions. Mechanical plant, on the other hand, means heavy capital and maintenance charges, and can rarely be employed for an average of 20 hours per week all the year round. For example, the 150-ton floating crane London Mammoth cost about 80,000*l*. Capital charges, including depreciation, amount to about 12,000*l*. per annum, or, say, 40*l*. per working day. Operating expenses, including crew, fuel, maintenance, etc., will add another 40*l*. per day; and, as the number of heavy lifts required is small, it is obvious that the charges for the use of the crane cannot be remunerative. Such a crane is essential in a first-rate port, however, and helps to attract and retain revenue-producing trade. In contrast to the heavy floating crane, there are several large flour mills at the docks which work night and day six days a week all the year round. Complete mechanisation, from the pneumatic discharge of grain from ocean-going steamers berthed alongside to road deliveries of flour by motor vehicles, is warranted by the high load-factor obtainable. Apart from general-purpose appliances, such as quay cranes and electric trucks, special plants are being more and more used for handling bulk commodities, such as grain, meat, fruit, cheese, and tobacco.

In new dock construction, an important factor is that of mechanical plant. In the early 'nineties of last century, the late Professor John Goodman took his engineering students at Leeds over part of the Manchester Ship Canal, then in course of construction, and I was greatly impressed not only with the character of the finished work, but also with the variety and scope of the plant employed. The plant was then almost entirely steam-driven; to-day we mostly employ electric power and the internal-combustion engine. Reinforced-concrete construction was then unknown in this country. I remember the curiosity with which I inspected the cropped end of a reinforced-concrete pile sent to the Admiralty by Messrs. Mouchel, from Southampton, about the end of last century. Now the dock engineer employs reinforced-concrete very largely, not only for foundation piles, but for jetties, warehouse construction, and many other purposes. Steel sheet piling is another modern development which is largely used both for temporary and permanent work. Pile-driving plant, concrete batching, concrete pumping and vibrating plant have developed out of all recognition during the century.

The use of concrete monolith construction, the lowering of ground water level by pumping from a series of filter wells, and the consolidation of ground by chemical impregnation, are helpful developments in dealing with foundations under difficult conditions. The use of compressed air on foundation and tunnelling work is much better understood, and the danger to the workmen can be overcome by proper precautions. All types of excavating machinery, including dredgers, have shown much progress in size, speed, and reliability. Notwithstanding all these improvements in plant, and advantages in methods of design, together with improved quality of materials, it should be noted that

* *Proc. Inst. C.E.*, vol. 129, page 1 (1896-7).

the capital cost of heavy construction works has more than doubled in the last forty years, and there has been little or no reduction in the time required for the work to be carried out. What can be claimed, however, is that difficult works can be carried through with much more assurance of success and freedom from accident, and that the design and quality of the finished work is better and more lasting.

In conclusion, I should like to say a word of encouragement to our younger members. I started work in the shops at a period of depression in the engineering trade, and it was difficult to get a job of any sort. It was equally difficult later on to get a move from the bench to the drawing office. It was nearly six years after leaving Leeds University before my scientific training began to be of much apparent use to anybody. I realise now that this period of hard grinding work was to my ultimate benefit, but in my eager youth I felt that my progress was very disappointing. The finest gift you can have for the serious business of an engineering career is courage and a determination to play your part in the adventure of life. Criticise your elders as much as you like, but don't stop at criticism. Show them that they can do much better with your help, and insist on helping. After the war there will be great work to be done in reconstruction of the shattered fabric of our national life. I am confident that our young engineers will rise to the occasion.

LOW LOAD-FACTOR POWER STATION AT OREM.

An electrical power station at Orem which has been specially designed by the Utah Power and Light Company for intermittent operation, and is used to supplement the output of five hydro-electric stations, is described in *The Electric World*. In order to minimise capital expenditure, a semi-outdoor design was adopted and a saving of 150,000 dols., compared with the cost of an equivalent totally-enclosed station, was thereby effected. The single boiler is of the tri-drum bent-tube type, with a heating surface of 18,600 sq. ft. and a continuous evaporative capacity of 200,000 lb. per hour at a pressure of 400 lb. per square inch and at a temperature of 750 deg. F. It is fired by a travelling-grate stoker, 20 ft. wide and 21 ft. long, the coal having a calorific value of 12,600 B.Th.U. per lb. Storage is available for 7,500 tons, which is taken by an elevator to a 150-ton concrete bin and thence discharged by gravity to twin screw-conveyors which deliver it to the stoker hopper. Only the stoker and lower part of the boiler are below the roof. No economiser or air heater is provided, though it is considered that the installation of these would have been justified, even with the locally prevailing fuel prices, if operation had been more continuous.

Induced-draught fans driven by totally-enclosed motors are installed on a concrete slab above the boiler. In addition to the main forced-draught fan, which supplies air to the stoker compartments, a smaller fan takes air from the boiler room near the front end of the stoker and delivers it through openings near the throat end of the furnace, thus creating turbulence and permitting widely-varying rates of combustion to be used and high CO_2 to be maintained without smoke. At the maximum output, the combustion rate is about 50 lb. per hour per square foot of grate area. During the first year of operation the boiler was laid off about every sixth week-end to remove ash accumulation on the furnace walls and tubes, but improvements in operating methods have recently increased the periods between shut downs to three months and the unit is now available for 95 per cent. of the time, if needed.

A single 15,000-kW turbine is installed and this exhausts into a two-pass condenser with a cooling surface of 16,000 sq. ft. The cooling water is drawn from the tail race of the company's hydro-electric station at Olmstead, 1,000 ft. away. This water, the temperature of which varies from 33 deg. to 70 deg. F., is circulated by a constant-speed motor-driven pump with a capacity of 46 cub. ft. per second. The alternator, which has an output of 18,750 kVA, generates three-phase current at 12·8 kV, which is stepped up to 44 kV by two 9,375-kVA transformers for transmission to the Olmstead bus bars. Duplicate controls are provided. Since its inauguration, four years ago, the station has operated for 11,000 hours, including 4,200 hours in 1939, when it showed a heat rate of 15,550 B.Th.U. per kilowatt-hour sent out.

Boulder-Dam Power Plant.—The U.S. Bureau of Reclamation has recently placed a contract with the General Electric Company, Schenectady, for an 82,500-kVA generator for installation in the Arizona wing of the Boulder-Dam power station.

NOISE-REDUCTION IN ENCLOSED SPACES.

In our account of the Building Trades Exhibition of 1938, a short paragraph was devoted to the problem of noise-reduction as involved in building construction. In our issue of November 4, 1938, page 529, means of sound-proofing rooms against transmission of external noise were indicated, and the allied problem of reducing internal noise by sound absorption was touched upon, the Accousti-Celotex tiles, of sugar-cane fibre, manufactured by Messrs. Celotex, Limited, North Circular-road, Stonebridge Park, London, N.W.10, being referred to in this latter connection. Under present-day conditions, in which many offices, etc., are more congested with increased activity and resultant increased noise, it would seem of interest to cite certain data on sound absorption in the office, which data have recently become available.

The data referred to are derived from certain tests made in the offices of an insurance company in the United States. This company, which has had some 300,000 sq. ft. of Accousti-Celotex tiling fitted to its offices, has, it is stated, come to the conclusion that an increase of 8·8 per cent. in efficiency of operation has been secured by the sound-absorption affected. Records were kept for a year preceding the fitting of the tiles and for a year after they had been installed. In three selected rooms the increase of efficiency of the persons working therein was, respectively, 9·2 per cent., 9·4 per cent., and 7·7 per cent. Typists' errors were reduced by 29 per cent., and calculating-machine operators' errors by 52 per cent. It is further stated that staff changes were reduced by 47 per cent. and absenteeism by 37·5 per cent. While, in our opinion, the last two percentages cannot, with certainty, be attributed solely to the reduction of noise, the efficiency and error figures are striking enough to warrant careful consideration, particularly as the data were derived from conditions less arduous than those often obtaining nowadays in British offices.

A detailed discussion of the principles of noise-reduction by sound-absorption is hardly necessary here, particularly as the apparent loudness or degree of annoyance at different noise levels does not correspond to measurement of loudness in phons. Briefly, however, it would appear from careful experiments that apparent loudness or annoyance increases much more rapidly at the higher loudness levels in phons than it does at the lower levels, with the result that a relatively small reduction in phons at the higher levels decreases the apparent loudness very considerably. As an illustration, Messrs. Celotex may be quoted as stating that a 7-phon reduction in a typing room with an average maximum loudness level of 70 phons results in a decrease of 43 per cent. in apparent loudness or real annoyance, which condition is equivalent to the effect gained by the removal of about 80 per cent. of the noise-making units. It is of interest to note that the tiles which, from the material employed, are of light weight, are not affected as regards their sound-absorbing properties by painting. The grade of tile fitted in any particular case varies with amount of noise normally present and the amount of absorption desired.

BOOKS RECEIVED.

Iowa State College of Agriculture and Mechanic Arts. Iowa Engineering Experiment Station. Bulletin No. 146. *Supporting Strengths of Cast-Iron Pipe for Water and Gas Service.* By Professor W. J. Schlick. Ames, Iowa, U.S.A.: The Director, Iowa Engineering Experiment Station. [Free.]

Canada. Department of Mines and Resources. Bureau of Mines. No. 803. *Talc, Steatite, and Soapstone; Pyrophyllite.* By H. S. Spence. Ottawa: Bureau of Mines, Department of Mines and Resources. [Price 50 cents.]

Technical Drafting. A Text and Reference Book on Graphics. By Professor C. H. Schumann. New York: Harper and Brothers. [Price 3·50 dols.]

Cutting Tools for Metal Machining. By Drs. Max Kurrein and F. C. Lea. London: Charles Griffin and Company, Ltd. [Price 16*s.* net.]

Aeroplane Recognition Tests. What Is It? Part II. London: Offices of "The Aeroplane," Bowling Green-lane, E.C.1. [Price 6*d.*]

Mechanical Engineering. The Profession and Its Opportunities. By W. H. Atherton. London: Sir Isaac Pitman and Sons, Limited. [Price 4*s.* net.]

Graphische Methoden zur Lösung von Wechselstromproblemen. By Albert von Brunn. Basle: Benno Schwabe und Co. [Price 18 Swiss francs.]

Waste Paper on a Railway.—During the three months, March, April and May, 823 tons of waste paper were collected on the L.N.E.R., as compared with 481 tons in the corresponding period of 1939.

PERSONAL.

Mr. W. S. M'Callum, assistant mining engineer to the Fife Coal Company, Limited, Leven, Fife, has been appointed chief mining surveyor for Scotland.

Mr. J. L. Adamson, A.M.I.Mech.E., has been appointed chief engineer of the Consett Iron Company, Limited, Consett, Co. Durham, in succession to Mr. J. Scholes, who, as stated in this column on page 288, *ante*, has retired after occupying the position for 21 years.

Mr. H. G. Ward, secretary of Messrs. Rowlands Electrical Accessories, Limited, 157, Hockley-hill, Birmingham, has been appointed a director of the company.

Sir Alexander Gibb, G.B.E., F.R.S., has agreed to continue in office as President of the Institution of Engineers-in-Charge for the session 1940-41.

The London office of Messrs. Higgs Motors, Limited, has been transferred to 6, Coppice-walk, Totteridge, N.20.

The Minister of Supply informs us that Mr. John Cecil Budd and Mr. William Mure have been appointed Joint Controllers of Non-Ferrous Metals in succession to Captain The Rt. Hon. Oliver Lyttleton, D.S.O., M.C., who has been appointed President of the Board of Trade. Mr. Budd will give special attention to copper and lead and Mr. Mure to zinc and brass.

The address of the British Iron and Steel Federation and the British Iron and Steel Corporation, Limited, is now Ashorne-hill, Ashorne, near Leamington.

Mr. Frank Gill, O.B.E., has succeeded Sir Alexander Roger as chairman of the Telephone and Telegraph Apparatus Export Group.

Mr. H. D. Mains, manager of the Glasgow office of Messrs. Davidson and Company, Limited, Sirocco Engineering Works, Belfast, has taken over the management of the London office of the Company. His place at Glasgow is being taken by Mr. R. S. Brown, who has hitherto been at the Manchester office.

The premises of the Institute of Marine Engineers at The Minories, London, E.C.3, are now closed and all communications should be addressed to the temporary offices at 73, Amersham-road, High Wycombe, Bucks. (Telephone: High Wycombe 1884.) Arrangements have, however, been made for the dispatch of library books, on loan, to members. Requests for such loans should be made by post to High Wycombe.

The Lord President of the Council has appointed Professor A. V. Hill, O.B.E., Sec.R.S., Sir Felix Pole, and Professor Sir Robert Robinson, F.R.S., to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research. Dr. W. H. Mills, F.R.S., Professor A. Robertson, F.R.S., Professor Sir Albert Seward, F.R.S., and Sir Harry Shackleton, have retired from the Council on completion of their terms of office.

Messrs. Wellworthy Piston Rings, Limited, Lymington, Hants, inform us that owing to pressure of national work they have been compelled reluctantly to terminate, as from October 31, the arrangements by which they acted as sole distributors for the "General" filter. Inquiries for the latter should now be addressed to Messrs. British Filters, Limited, Aircraft House, Market Harborough, Leicestershire.

Messrs. George Cohen, Sons and Company, Limited, have transferred their registered and general offices to Broadway Chambers, Hammersmith, London, W.6. (Telephone: Riverside 4141), to which all correspondence concerning their accounts, scrap-iron, dismantling, shipping and railway departments should be addressed. The firm's non-ferrous metals department and wharf will, however, be maintained, as heretofore, at 600, Commercial-road, London, E.14.

TENDER.

We have received from the Department of Overseas Trade, Great George-street, London, S.W.1, particulars of the undermentioned tender, the closing date of which is as stated. Details may be obtained on application to the Department at the above address, quoting the reference number given.

Scum and Sludge Scraper, direct-current electrically driven, transfer-platform rails, and accessories, for Giza purification works. Main Drainage Department, Ministry of Public Works, Cairo; November 5. (T. 22,256/40.)

Society of Chemical Industry.—Arrangements are in hand for carrying on the work of the Chemical-Engineering Group of the Society of Chemical Industry. During the forthcoming session, the Group will act in the closest co-operation with the Institution of Chemical Engineers and any meeting arranged will be held jointly by the two bodies. Advance proofs of papers, when available, will be sent to the members of both bodies.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—The possibilities of a substantial improvement in trade with the South American countries, as a result of the decision of the Government to send a trade mission to that Continent, were again being discussed on the Welsh steam-coal market last week. This has been always one of the largest outlets for Welsh coals, although, during recent years, Germany has made considerable headway. With the outbreak of war, however, German shipments were cut off by the British blockade and, as a consequence, there was a considerable call for supplies for South America. Unfortunately, at that time, South Wales was chiefly concerned with maintaining deliveries to France and coals were unobtainable, and when supplies did become available, following the collapse of France, it was found that South American buyers had entered into heavy commitments with United States producers. These sellers have retained their hold on the market as a result of the very considerable advantage which they enjoy in the matter of freight rates. Another direction in which special efforts are being made to extend trade is to Canada. Normally, the South Wales anthracite trade with the Dominion comes to an end about this time of the year, but owing to the present state of the anthracite trade due to the collapse of the Continental markets, it is hoped to extend the season. There is no indication of any expansion in overseas demand on the steam-coal market, although there is some business passing from Portugal, Spain and South America. The inland trade continues to provide an outlet for the bulk of the collieries' present lessened production and enables sellers to hold back for the full late prices.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The past six months have been exceedingly busy for steelmakers, engineers and toolmakers, and excellent deliveries of all types of products have been made to consuming works all over the country. In addition, good results have been obtained from efforts to improve export sales. The recent heavy buying of all types of raw and semi-finished materials shows no signs of weakening. In the case of some classes of steel, further calls are being made on producers. Melting plants, which have been greatly extended during the past nine months, are turning out record outputs. Sheffield has no complaint regarding supplies of hematite and pig iron, and the deliveries of scrap are ample for all requirements. The heavy machinery and engineering branches are considerably busier than they were a year ago. The demand for ironworks' and steelworks' machinery and related equipment is the heaviest for some time; contracts are on hand for rolling mills, hydraulic presses, lathes, and other types of machinery. Grinding and crushing plant is required by South Africa, India and South America. Despite the close season, makers of agricultural machinery and parts are particularly busy and are preparing for the heavy buying that is expected early in the new year. Electrical-equipment makers have well-filled order books, and tool makers report that there is no diminution in the demand.

South Yorkshire Coal Trade.—Little improvement has taken place in the export market, but the inland call for all types of fuel has been maintained. Buying for stocking purposes is on a large scale. There is a strong demand for industrial coal, including steams, smalls, and slacks, and electric power stations are consuming increased tonnages of smalls. The house coal market is more active, and most classes of coke are in strong request.

MENAI BRIDGE TOLLS.—The Minister of Transport informs us that tolls for the use of the Menai Suspension Bridge, which connects Anglesey with the mainland, will be abolished as from January 1, 1941. This decision will mean a considerable saving to motorists and other road users, including owners of horse-drawn vehicles.

BROOMWADE PORTABLE AIR COMPRESSORS.—We are informed that owing to circumstances arising from the national emergency, Messrs. Broom and Wade, Limited, High Wycombe, are unable to obtain the Lister Mark 27-3 and Mark 38-4 Diesel engines, hitherto used in their SVD 1 and SVD 2 portable air-compressor plants, in sufficient quantities to meet the current demands. As an alternative, however, the firm has secured numbers of the Buda Diesel engines, manufactured by the Buda Company, Harvey, Illinois, U.S.A. Consequently the SVD 1, 110-cub. ft. air compressor will be equipped with the Buda 4-DJ 212 four-cylinder engine, as an alternative to the Lister 27-3 engine. The SVD 2, 167-cub. ft. compressor will be furnished with the Buda 6-DT 389 six-cylinder engine, as an alternative to the Lister 38-4 engine.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Record outputs of iron and steel, supplemented by substantial import of commodities from the United States, meet the essential needs of priority delivery claims of firms directly engaged on work of national importance, and provide some additional tonnage for other purposes, but to ensure adequate supplies to quarters where material is most required, the regulations under the control of distribution scheme are strictly enforced. Raw materials are still plentiful, and the ample tonnage of scrap available has appreciably reduced the demand for foundry and basic iron, and, although foundries are much busier than they were in the first half of the year, they are receiving adequate deliveries for all requirements.

Cleveland Iron Trade.—Cleveland pig continues to be scarce and there are no prospects of a material addition to the light intermittent make, but the shortage is of no importance as foundry-iron consumers have no difficulty in obtaining, under licence, full deliveries from elsewhere. Midland brands are coming to hand in considerable quantities, and Scottish makes are arriving for use at North East Coast works. Merchants have control of slightly more tonnage than formerly, but are still handling only moderate parcels of Cleveland pig, the fixed prices of which are based on No. 3 quality at 120*s.*, delivered to local buyers.

Hematite.—The demand for hematite is still in excess of the supply. The furnaces in blast are turning out maximum tonnages, and there seems little likelihood of additional plant being put into operation. The heavy output is absorbed as it becomes available, and consumers are pressing for larger deliveries. The increasing needs of makers' own consuming works absorb the bulk of the production, and rationing of buyers is still unavoidable. It is expected, however, that the situation will be materially improved by the arrival of cargoes of American hematite. The recognised market values of East Coast brands are ruled by No. 1 description at 131*s.*, delivered to North of England customers.

Basic Iron.—The output of basic iron is being maintained at a very high level, but is all retained for use at the producers' adjacent steelworks. The nominal price remains at 113*s.*

Foreign Ore.—The imports of foreign ore continue to exceed expectation, and stocks are considerably larger than they were at the outbreak of the war.

Blast-Furnace Coke.—Transactions in Durham blast-furnace coke are few, local users having bought as extensively as they consider necessary and sellers being disinclined to add to their extensive contracts. The stabilised quotations are based on good medium qualities at 33*s.* 5*d.* at the ovens.

Manufactured Iron and Steel.—Imports of American bars, billets, blooms, etc., together with the well-maintained home make of semi-finished iron and steel, are fully sufficient to meet the heavy requirements of the re-rolling mills. Finished-iron firms are turning out an increasing tonnage, and steel producers have to keep their plant fully occupied to deal with the demand. Much of the output is required for constructional engineering work, and for shipbuilding. Soft-steel billets are 10*l.* 10*s.* to 10*l.* 15*s.*; hard billets, 11*l.* 17*s.* 6*d.*; joists and angles, 13*l.* 13*s.*; heavy plates, 14*l.* 3*s.*; and boiler plates, 15*l.* 0*s.* 6*d.*

Scrap.—Steelworks are well placed with regard to scrap supplies, but still readily accept deliveries of the better grades in order to build up stocks. Trimmings, borings and light cast iron are fairly plentiful, and rather slow of sale.

THE BRITISH RHEOLOGISTS' CLUB.—Since the outbreak of war new and urgent problems concerning the flow and deformation properties of materials (rheology) have arisen in many industries and in research, and a group of British rheologists have therefore formed a Club for mutual help and discussion, and Professor G. I. Taylor, F.R.S., has accepted the presidency. The objects of the new Club are "to co-ordinate the activities of rheologists in Britain during the war, to further the appreciation of the importance of rheology in industry and to facilitate the pooling of information (where it is desirable) with respect to problems and new methods of research." Membership of the Club is open to any individual working or interested in rheology who is resident anywhere in the British Empire, and there is a nominal subscription of 5*s.* per annum. Arrangements are in preparation for an inaugural meeting of the Club to be held at the National Institute for Research in Dairying, University of Reading, on November 16 next, when it is proposed to hold an informal discussion on a topic to be selected, followed by an inspection of the rheological apparatus, including some recent developments. Further details of the Club may be obtained from the Honorary Secretary, Dr. G. W. Scott Blair, c/o The Institute of Physics at The University, Reading, Berks.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF MECHANICAL ENGINEERS.—To-day, 2.30 p.m., Storey's-gate, St. James's Park, Westminster, S.W.1. Joint Meeting with THE INSTITUTION OF PRODUCTION ENGINEERS. "The Desirability of Acceptance Test Charts for Machine Tools."

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Saturday, October 26, 2 p.m., Neville Hall, Newcastle-upon-Tyne. General Meeting. Inaugural Address by the President, Captain Stanley Walton-Brown.

MANCHESTER ASSOCIATION OF ENGINEERS.—Saturday, October 26, 2.30 p.m., Engineers' Club, Manchester. "Principles and Applications of Automatic Temperature Control," by Mr. M. J. Gartside.

INSTITUTION OF CIVIL ENGINEERS.—*Yorkshire Association:* Saturday, October 26, 2.30 p.m., The Hotel Metropole, Leeds. Joint Meeting with the *Yorkshire Branch* of THE INSTITUTION OF STRUCTURAL ENGINEERS. "The Channel Tunnel," by Mr. T. J. Gueritte.

INSTITUTION OF ELECTRICAL ENGINEERS.—*Scottish Centre:* Tuesday, October 29, 6.15 p.m., The Royal Technical College, George-street, Glasgow, C.1. Informal Discussion on "The Development of Potential Water-Power Resources in Scotland," to be introduced by Messrs. J. Henderson and W. McFarlane.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, November 1, 6 p.m., The Mining Institute, Newcastle-upon-Tyne. Andrew Laing Lecture. "Foundations of the Electrical and Mechanical Transmission of Energy," by Emeritus Professor W. M. Thornton.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—One of the main features of the Scottish steel trade during the past week has been a very heavy demand from the shipbuilding industry. This industry alone is absorbing a large proportion of the present output of steel but other consumers have also been making inquiries of considerable importance and practically every ton produced is quickly taken up. Constructional engineers are also pressing for supplies. Both heavy and light material are in demand and makers of black-steel sheets have so many orders booked that their plant is kept operating at full capacity. The orders for galvanised sheets have increased considerably and the output, at present, is on a large scale. The supply of raw materials is now quite satisfactory as considerable tonnages have arrived from overseas and the outlook for the winter months is now much better than seemed probable even a few weeks ago. The following are the market quotations:—Boiler plates, 15*l.* per ton; ship plates, 14*l.* 3*s.* per ton; sections, 13*l.* 13*s.* per ton; medium plates, rolled in sheet mills, ¼ in. and thicker 18*l.* 7*s.* 6*d.* per ton; mild-steel black sheets, No. 21-24 gauge, close annealed, 19*l.* 7*s.* 6*d.* per ton; galvanised sheets, plain, No. 21-24 gauge, 23*l.* 2*s.* 6*d.* per ton, and corrugated, No. 24 gauge, 22*l.* 12*s.* 6*d.* per ton.

Malleable-Iron Trade.—Little change has to be reported in connection with the malleable-iron trade of the West of Scotland and the recent improvement in demand has been well maintained. Order books are well filled and a good output is being obtained. The re-rollers of steel bars have ample stocks of semies. These will ensure the steady running of plant to meet the heavy demands of consumers. To-day's quotations are as follows:—Crown bars, 15*l.* 2*s.* 6*d.* per ton; best iron 15*l.* per ton; No. 3 bars, 13*l.* 7*s.* 6*d.* per ton; No. 4 bars, 13*l.* 12*s.* 6*d.* per ton; re-rolled steel bars, tested, 15*l.* 11*s.* 6*d.* per ton, and untested, 15*l.* 8*s.* 6*d.* per ton; angles and tees, 4 in. and under, tested, 15*l.* 1*s.* 6*d.* per ton, and untested, 14*l.* 18*s.* 6*d.* per ton.

Scottish Pig-Iron Trade.—The demand for Scottish pig-iron continues strong, especially for basic iron, which is in steady request by the steel makers. Iron-ore supplies are good and stocks have accumulated. Consumers of foundry iron are more active and there has been a notable improvement in the demand.

THE INSTITUTION OF CHEMICAL ENGINEERS.—The Secretary of the Institution of Chemical Engineers informs us that application forms for the 1941 examination for associate membership are now obtainable. Particulars regarding the examination and a memorandum entitled "The Training of a Chemical Engineer," may be obtained from the Honorary Registrar, at the Institution, 56, Victoria-street, London, S.W.1, to whom the application forms should be returned by December 16.

WELDED RIGID-FRAME FACTORY BUILDING.

(*For Description, see page* 321.)

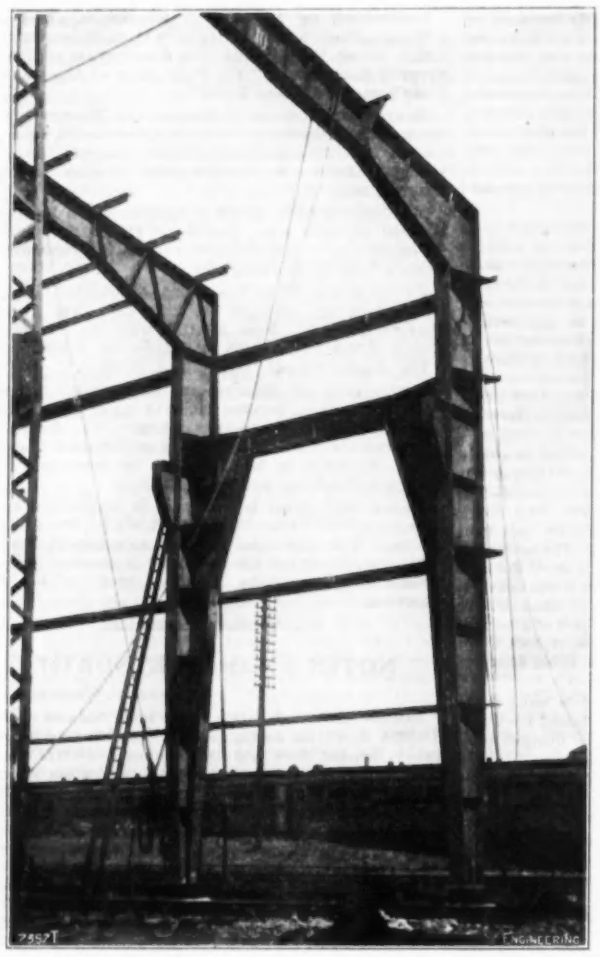

Fig. 70. Brake Portal.

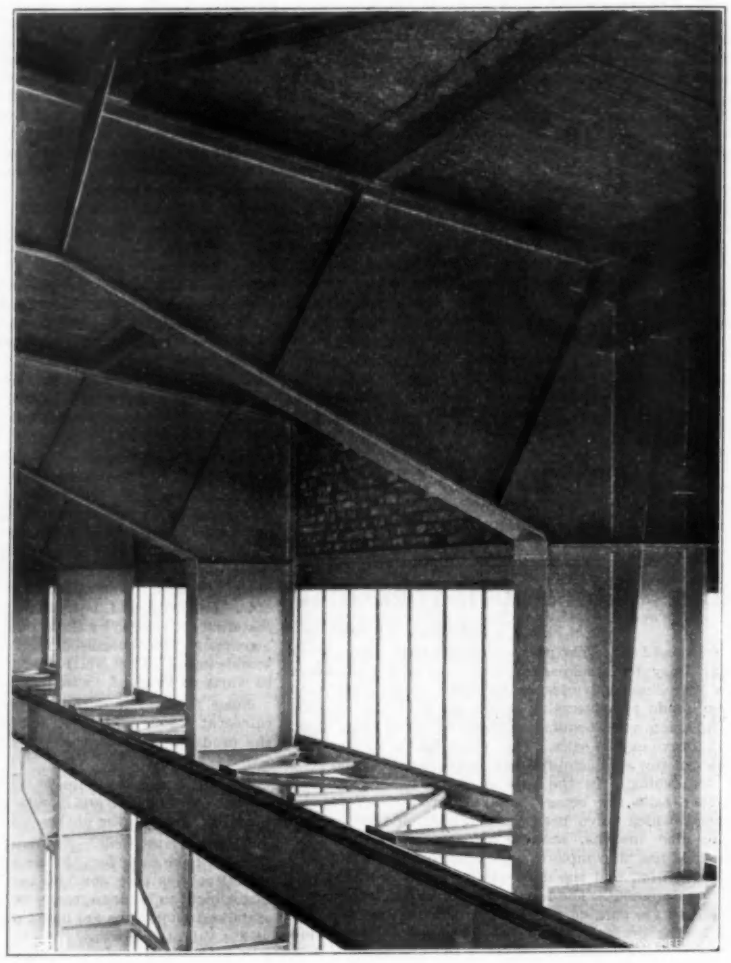

Fig. 71. Wind Portal in End Bay.

THE RECOVERY OF SCRAP METALS IN THE UNITED STATES.

Some interesting statistics relating to the recovery of scrap non-ferrous metals in the United States, during 1939, have recently been issued by the Bureau of Mines at Washington. Thus, the aluminium salvaged for re-use during the year aggregated 50,000 short tons, 50 per cent. of the total being derived from scrap castings, 27 per cent. from various types of scrap sheet, 7 per cent. from borings and turnings, 6 per cent. from clippings, 2 per cent. from wire and cable, and 8 per cent. from miscellaneous sources. The copper recovered from scrap amounted to 499,700 short tons, of which 151,370 tons were recovered as essentially pure metal, 162,400 tons were salvaged from brass scrap, and 182,730 tons from alloys other than brass. The lead salvaged from scrap metals amounted to 241,500 short tons, of which 86,900 tons were in the form of refined lead and 154,600 tons in the form of alloys of the metal. Discarded lead storage batteries accounted for 51 per cent. of the total salvaged, cable lead for 9 per cent., bearing metals for 4 per cent., and solder for 3 per cent. The remainder was obtained from miscellaneous sources, including drosses and residues, type metals, and various other alloys. The total of the nickel recovered from scrap metals was 2,920 short tons. Sixty per cent. of this quantity was derived from nickel silver, 15 per cent. from nickel clippings and anodes, hangers, baskets and similar equipment, 12 per cent. from ferrous alloys, 11 per cent. from Monel metal, and 2 per cent. from stainless steels. De-tinning plants accounted for 4,089 tons of the 29,160 short tons of tin salvaged from scrap during the year. Other sources included solders, drosses, bearing alloys and type metals. The zinc recovered from scrap totalled 189,640 short tons. Alloys containing copper, in addition to the zinc, constituted the principal source, accounting for 45 per cent. of the total, while zinc drosses and skimmings contributed 42 per cent.

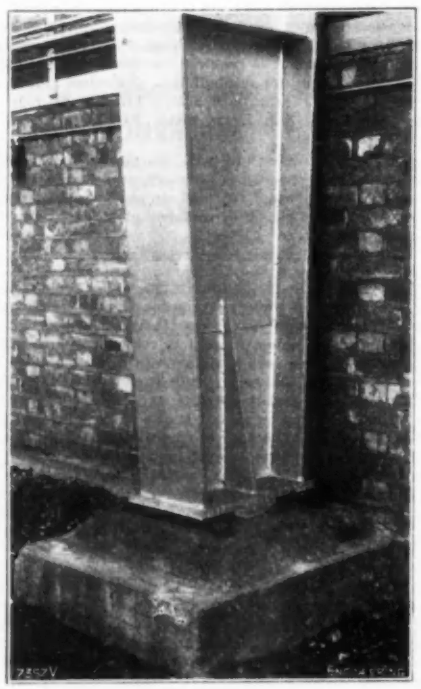

Fig. 72. Pin Joint for Portal Frame.

Fig. 73. Base of Main Portal Showing Connection of Brake Portal.

WELDED RIGID-FRAME F

(For Description, see pa

Fig. 64. Leg of Frame Ready for Hoisting into Position.

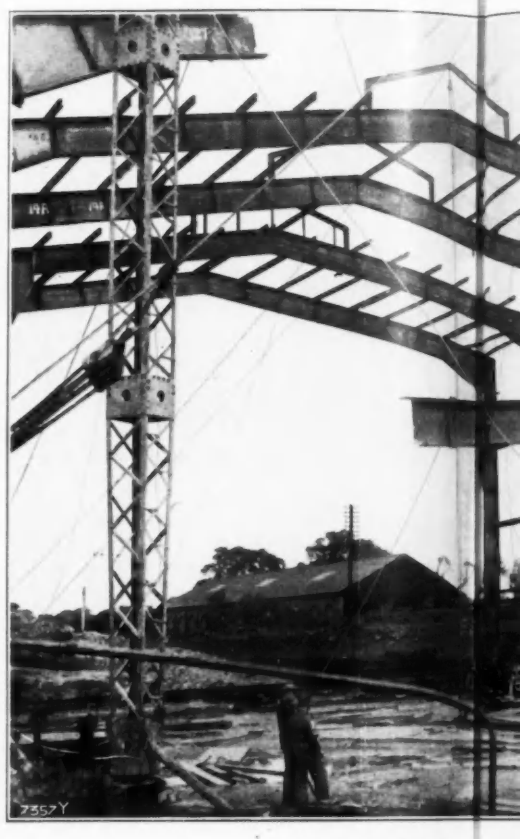

Fig. 65. Main Portal du

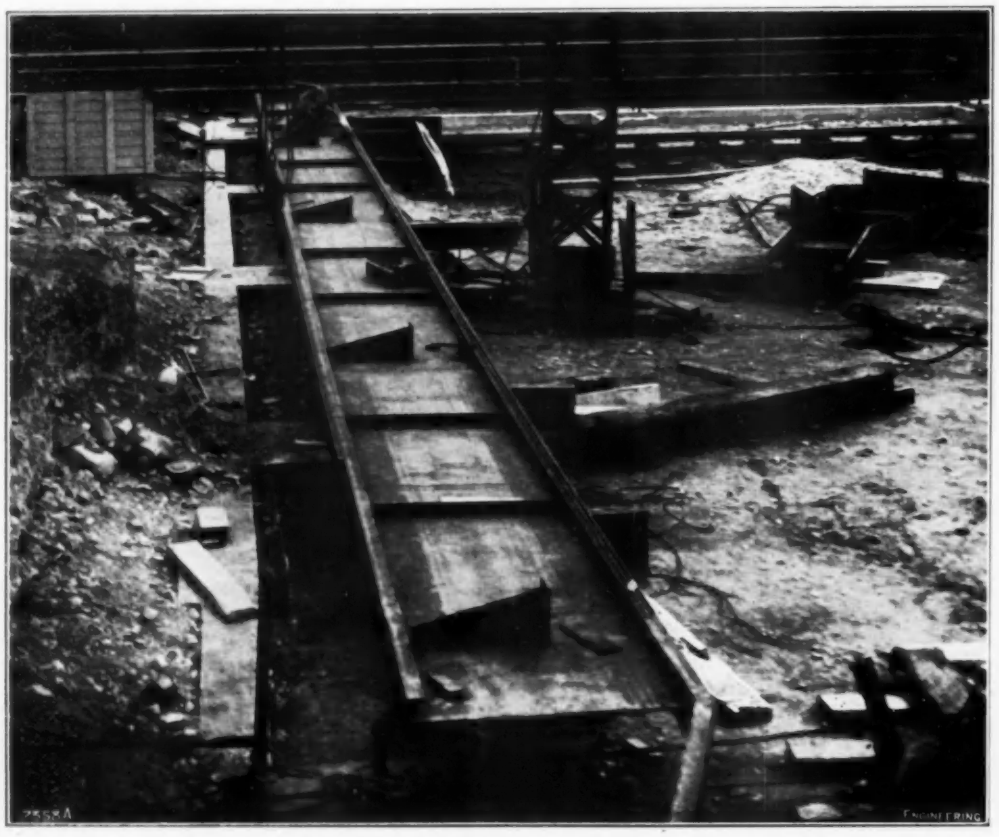

Fig. 67. Gable-end Wind Girder Assembled and Welded.

Fig. 68. Interior of Compl

AME FACTORY BUILDING.

Description see page 321.)

IN PORTAL DURING ERECTION.

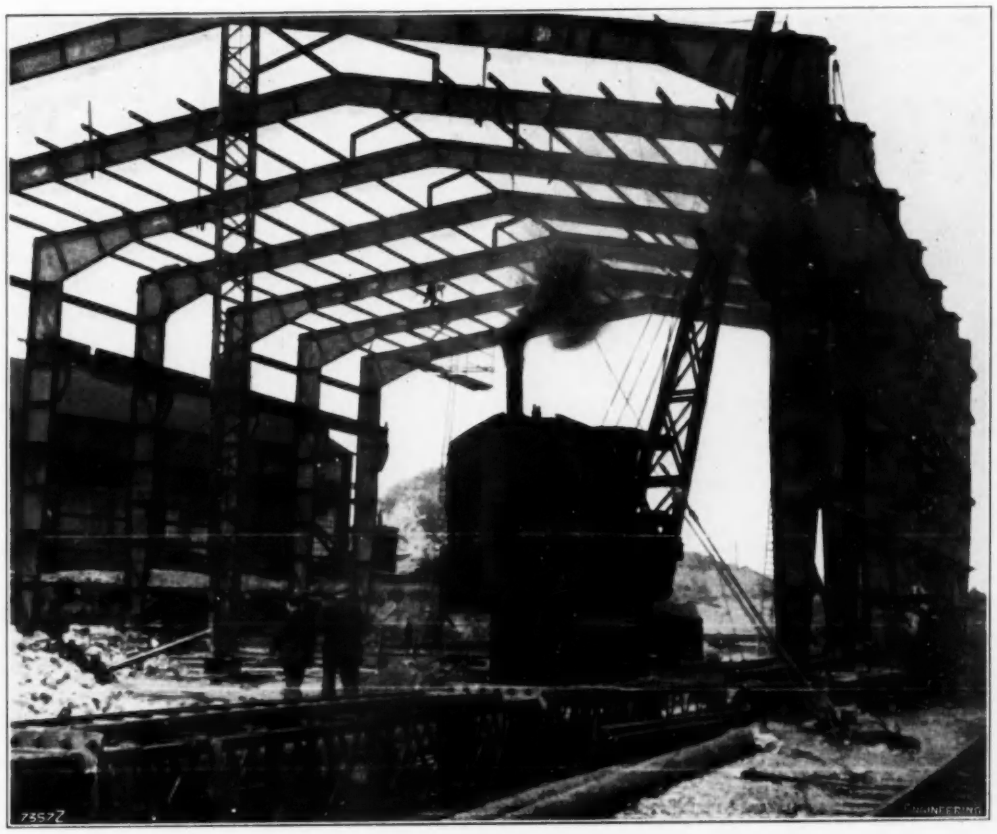

FIG. 66. SEVEN MAIN PORTALS ERECTED WITH GANTRY GIRDERS.

TERIOR OF COMPLETED SHOP.

FIG. 69. EXTERIOR OF COMPLETED SHOP.

UNIV. OF MICH.

ENGINEERING.

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ENGINEERING

FRIDAY, OCTOBER 25, 1940.

VOL. 150. No. 3902.

THE AIR WAR.

FIVE weeks have elapsed since the war in the air was last discussed in these columns, and enough has happened in the interval to render a further examination of the situation appropriate. In general terms, the enemy's efforts have been more and more concentrated on London. Raids in the day time have tended to become increasingly sporadic. On the other hand, there have only been short periods during the night when it has not been necessary for the population to be upon the alert. This persistency, however, has not produced commensurate results. At the beginning of the period, there was some indication that the intensification of the protective barrage was preventing the enemy from reaching the inner areas of the Metropolis. The consequence was that districts both just outside and more remote suffered the brunt of the attack, in spite of the fact that their military importance was usually negligible. The enemy sought to overcome the disability of darkness by the frequent use of flares. It seems probable, however, that the utility of these is limited, and that what value they have can be largely counteracted by the anti-aircraft defences. With the coming of the "hunter's moon," the advantage swung, at least temporarily, to the German side, and during the last fortnight there is no doubt that the moonlight conditions have been of considerable assistance to the attacking forces, enabling them once again to penetrate to the inner areas of London, and to exercise greater discrimination in the selection of targets. They have also been assisted, as they were so often during the war of 1914-18, by other meteorological conditions. Indeed, except on one occasion, neither wind, frost or rain has been sufficient to prevent them making their nightly excursions to this country from the favourably situated aerodromes in Northern France and elsewhere.

It may be frankly stated, therefore, that we have not so far got the enemy's measure in the air at night to the same extent that we have succeeded in achieving it in the day time. Neither, it must be added, has the enemy got the measure of ours; nor can it be denied that the Royal Air Force are wreaking more havoc on German harbours, oil plants, power stations, factories and communications than the *Luftwaffe* is on those of Britain. Indeed, an interesting feature of the situation is that, while the British bombers must be playing a considerable part in slowing down Germany's war efforts, they have done singularly little to reduce the efficiency of this nation's war machine. In this connection, it may perhaps be argued that, impressive as is the list of places visited by our machines on most nights, there is much to be said in favour of concentrating on a few main objectives at a time. For instance, Krupps' large establishment at Essen has been visited on more than one occasion, and each time, it is reported, considerable damage has been done. It cannot be doubted, however, that an attack on such an important factory with a larger proportion of the forces available would not only have been more difficult to resist, and would thus have effected more damage, but would have rendered the necessary salvage and repair work progressively more onerous than do successive smaller attacks. This, however, is a matter which must necessarily be left to the strategists, who have, no doubt, studied the subject in the light of fuller information than is available to the general public, and are not unaware of the desirability of striking a knock-out blow at such an important part of the enemy's productive resources.

The greater problem, however, is rather how to repel the enemy's attacks on this country at night by inflicting upon him such losses as will cause him to pause, as he has done in the day time. As we have said, neither side has found a completely effective antidote to night bombing attacks, a state of affairs which can easily be explained by the difficulty of locating and bringing to action a single bomber meandering more or less at random in several thousand cubic miles of space. We are promised, however, that a solution is on the way, and trust this is so. So far the public have stood the strain wonderfully well, though they may well deplore the lack of foresight on the part of those responsible for their protection and criticise the rather hand-to-mouth methods by which attempts are now being made to correct past mistakes. Even British endurance has its limits, however, and it would be well that the fullest ingenuity and energy should be exercised to prevent the infliction of burdens which should be avoidable.

The Government, however, must not only be concerned with defence as such, nor with that counter-attack which is only defence in another form. One of its principal preoccupations must be to prepare for the time when the growing productive efforts of British and American industry shall have given us numerical superiority in the air, and to decide how that superiority is to be most effectively utilised in combination with the military and naval forces. As regards this latter problem, there are two schools of thought. It may be recalled that, at the beginning of the war of 1914-18, such air forces as Britain possessed were utilised as auxiliaries to the military and naval forces, to act as scouts and spotters and generally to assist the advancement of the land and sea campaigns. This type of organisation is still largely utilised by the Germans and was effectively employed by them in the campaigns in Poland, Holland, Belgium and France. It is only human nature, besides being good tactics, to adopt the enemy's policy when it is successful and to improve upon it when that seems feasible. What the Germans have done with the tank, which, after all, was a British invention, is an outstanding example of such procedure. It is necessary before taking such a step, however, that all the implications should be considered and that changes should not be made merely for the sake of making them.

Towards the end of the war of 1914-18, the Royal Air Force was organised as a body separate both from the Navy and the Army. It is still separate, though the Navy has possessed a relatively small number of machines for its own use for some years. Under successive Secretaries of State, and especially under Lord Trenchard, the whole conception of this separately-organised body has been unity and the offensive. It is not too much to claim, as Lord Trenchard did himself in the House of Lords the other day, that it was this spirit of unity which had made possible the successes of to-day. He therefore

deprecated the suggestion that the air forces should be split into three, one under the control of the Admiralty, another under the control of the War Office, and a third, apparently, still under the control of the Air Ministry. The reason for this suggestion is that, when the time comes for the Army to start active compaigning, recent experience has shown that it will be necessary for it to be supported by sufficient air power. Further, it is argued that, as this air power will be required for military operations, it is essential that it should be solely under Army control. Anything else means division of authority and contains the seeds of ultimate, if not immediate, weakness. If such an argument had been advanced at a time when the Royal Air Force had shown signs of weakness, it would not, perhaps, have been surprising. On such occasions it is natural to seek for a culprit and to investigate every possible means of bringing about an improvement. That it should have been made at a time when the Royal Air Force has proved itself in the eyes of the world is less easy to explain. It seems to be based on a very pessimistic conception of the ability of the staffs of the War Department and the Air Ministry to co-operate for the common good, and of a wrong idea of the steps that should be taken to build up an adequate air strength, in order that, in the fullness of time, our strategical scheme may be imposed upon the enemy.

The position was well put by Lord Snell in the debate in the House of Lords, to which we have already referred. The work which the Air Force had done in the recent critical months, he said, had shown that its foundations had been well and truly laid. Its achievements in the face of an enemy greatly superior in numbers and types of aircraft had been so impressive as to make any suggestion for reorganisation on a different basis somewhat superfluous. There could be no doubt that development was on thoroughly sound lines, and he hinted that it was an improvement on the system of divided control existing during the last war. It is only fair to the critics to say that they do not advocate divided control so much as three air forces, but if an analogy may be drawn from electricity supply, it has been found that separation is not so efficient nor so economical as interconnection. Until, therefore, an air superiority of three to one has been attained over the enemy, it should be obvious that one force capable of carrying out multifarious duties as occasion requires is superior to a necessarily smaller and specialised body. The case of the Fleet Air Arm cannot be utilised as an argument against this policy; the conditions are quite different.

The organisation of the Royal Air Force is based on a certain strategical idea; but, to bring that idea to fruition, careful schemes of training and lay-out have had to be prepared. The machines have had to be designed with one eye on the underlying principles and they have had to be produced under the same conditions. That strategy, organisation, design and production have been satisfactorily welded into an efficient whole is amply proved by the results of the past few weeks. The underlying strategy cannot be disturbed without a greater or less disturbance of the other factors; and if it were disturbed, the effect on the work of the aeronautical engineers would be profound. They would have to revise many of their ideas and alter their whole outlook. Nor would the disturbing influence be confined to the production side; the whole unavoidably elaborate organisation for maintaining the air squadrons in service would be affected.

At present, attention is naturally focussed on events on the shores of the North Sea and the English Channel, but it must not be forgotten that the Royal Air Force operates in many remote corners of the Empire where it would be quite impracticable to maintain a separate air arm under the control of the small local military forces. The consequence of such a fundamental change of policy at the present time could only be a slowing down of the machine when a progressive speeding up is more than ever necessary. It would require much more forcible argument than have yet been put forward in favour of the change to permit such an outcome to be regarded with equanimity.

LOOKING AHEAD.

At the outbreak of the war, Mr. Neville Chamberlain announced that the Government plans for its conduct contemplated a struggle of three years' duration; and the broadcast speech addressed to the French nation on the evening of Trafalgar Day by his successor, Mr. Winston Churchill, contained no hint that any modification of this estimate was in the minds of the present Government. In such circumstances, it requires some courage to indulge in speculation regarding the most efficient utilisation of the eventual peace; not because there is any doubt as to the relative positions of Great Britain and Germany when that day comes, but rather because of the difficulty in predicting what changes may have been wrought in the structure of the nation's life, and what may be the reaction upon it of the enforced sterilisation of all normal industrial, commercial, scientific and cultural activity in the European states with which Britain had been accustomed to maintain a constant interchange of commodities and ideas. Nor can any precise estimate be made of the ultimate effect of some of the emergency measures that the exigencies of war have imposed on the internal economy of the British Isles and the deep-rooted social customs of a people who, for all their occasional outbursts of modernistic thought and expression, are at heart as incurably insular as ever they were.

Despite the obvious difficulty of arriving at any clear indication of "the shape of things to come," however, two newly-elected presidents of technical institutions have ventured some forecast of the trends to be looked for, or to be prepared against. Mr. Wilfrid Ayre, an abridgment of whose address to the Institution of Engineers and Shipbuilders in Scotland is concluded on page 339 of this issue, evidently anticipates a keen struggle for commercial supremacy, perhaps even for survival; not so much against the competition from other nations, apparently, as against that of similar undertakings within the country, suddenly released from the restricting influence of an all-embracing policy of controlled production for war, to compete in a free market for orders which an urgent but impecunious clientele will be obliged to place on a basis of least cost and earliest delivery. If it be thought that his outlook is too strictly materialistic, at least the justification can be offered that the firm of which he is the head was born in just such circumstances, and has survived the difficulties of the subsequent years by steady adherence to the principles that he advocates.

The views which Mr. W. A. Woodeson addressed, on October 18, to the North-East Coast Institution of Engineers and Shipbuilders ranged over a wider field and were concerned less with problems of internal organisation and individual preparedness than with the advances to be expected and sought in the technique of materials and their utilisation. Shipbuilding as an industry he mentioned hardly at all, although he made a strong plea for shipping as a whole, urging that insistent demands must be made on the authorities, in the future, to ensure that British shipping shall operate under conditions not less favourable than those of its competitors. For the rest, however, his survey was one of the future of engineering and its allied sciences, grouped in the alliterative classifications of "materials, methods, mechanisms and men." Mr. Woodeson disclaimed the role of prophet, but suggested that the indications of the present might be accepted as a broad basis for a reshaped attitude to the future—a future in which, as he said, whatever may be the fruits of this war, we shall face a new world, calling for methods elastic enough to take account of its new factors.

Prominent among the new factors which are already potent influences in moulding engineering practice are the use of welding as a method of fabrication, and the extending employment of the alloys of aluminium and magnesium. Of welding, it is sufficient to say that its place in the general system of engineering production is now fully secured, and the rapidly developing technique of design, necessary if the widest benefits are to be secured from its use, shows no sign of approaching finality. The parallel development in the use and scope of alloy irons and steels, to which Mr. Woodeson also referred, is in itself an indication of the continued need for an open mind in dealing with possible extensions of this new art, and of the unwisdom of attempting too soon to codify its application in too rigid a framework of rules and regulations. Fortunately, most of those who are most intimately concerned with these developments are relatively young men, who have grown up with the practices which they study and employ, and whose outlook, while well informed by experience of existing methods, is characterised by a constant readiness to examine new ideas and to test them by full-scale experiment.

In discussing the question of materials, Mr. Woodeson put forward the interesting hypothesis that the world is now in process of transition to a new "Age," in which aluminium will seriously challenge iron and steel as the basic metal of industry. He expressly stated that, in his opinion, iron would never be completely displaced as an engineering material, but considered that the promises of improvement in the mechanical properties of aluminium, due to additions of silicon, copper and manganese, and taken in conjunction with the progressive cheapening of production, offered good prospects that the already rapid expansion in its use would be further accelerated. The crucial need, however, if aluminium alloys are to compete seriously with iron in ordinary industrial applications, is for the development of some reasonably cheap method by which it can be extracted from clay. If this could be achieved, Mr. Woodeson suggested, one of the root causes of war might well be eliminated, as almost every country of importance would have its own ample supplies of the basic material. It may be questioned, though, whether this might not prove an additional inducement to some nations to press on with clandestine preparations for more wars, unless means can be found to exorcise their ingrained predatory tendencies.

Such comparatively little-used metallic elements as beryllium, cæsium, lithium, palladium and zirconium, it was suggested, might be increasingly employed if their extraction could be made less laborious, and, therefore, cheaper. We incline to the view that there are greater possibilities of a direct return from research in this field than are to be found in the continued attempts to use coal dust as fuel in internal-combustion engines, to which Mr. Woodeson also referred; but there will be general agreement with his opinion that "we should hold fast to our faith in such experiments, for, sooner or later, the uses of coal as a fuel will be greatly modified."

A renewal of attempts towards a closer co-ordination of the activities of the many technical institutions, qualifying and otherwise, is to be expected to occur at fairly regular intervals, and offers enticing prospects of combined efforts to attain some, at least, of the aims that they possess in common. It must be remembered, however, that a number of these organisations began as offshoots from older institutions, formed as a protest against the real or fancied neglect of their members' particular interests. The individualistic traits which led to their formation have not weakened by the passage of time, and may form as serious an obstacle to any intimate fusion of interests as the practical objections to an exclusive use of the metric system in British manufactures and commerce have proved to be, hitherto, in the path of those who, like Mr. Woodeson, advocate the abolition of the "irregular British standards of size, mass and money values" in favour of a universal system of measurement. This is a topic which has been very thoroughly ventilated in the past, and many have been the attempts to argue that, because the metric system has been successfully adopted in so many countries, it should be equally practicable in this. Two important points, however, are often overlooked; namely, that none of the "metric countries" was at all comparable with Britain in the scope of its industrial operations at the time when the change was made, nor possessed such numerous and intimate colonial connections, which would have to be taken into account before so fundamental a change could be effected.

NOTES.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE delivery of the presidential address before the Institution of Mechanical Engineers has hitherto been the occasion for a crowded hall, and doubts had been expressed that, this session, it would not be possible to arrange for a meeting owing to the early hour at which it would be necessary to hold it and present-day difficulties of travel. Nevertheless, on Friday, October 18, there was a good attendance to hear the President, Mr. Asa Binns, Wh.Ex., deliver his address, "Mainly The Port of London." The address, of which an abridgment will be found on page 325 of this issue, was preceded by an informal luncheon at the rooms of the Royal Empire Society, some 175 members and ladies attending. The Institution of Civil Engineers was represented by the President, Sir Clement D. M. Hindley, K.C.I.E., and representatives were present also from other institutions. At the conclusion of Mr. Binns' address, a vote of thanks was proposed by Mr. Charles Day, past-president, who alluded to the president's authoritative position as former chief engineer to the Port of London Authority, which made his address particularly informative. The position, moreover, involving varied problems in civil, mechanical, and electrical engineering, had enabled Mr. Binns to render great service to the Institution. The vote was seconded by Brigadier-General Sir Magnus Mowat, C.B.E., who recalled that he and Mr. Binns had entered the Institution in the same year, and that he had had at one time the advantage of being associated with the president in the work of the Port of London Authority. The vote of thanks was accorded with acclamation. Mr. Binns then announced that the James Watt Medal Committee had unanimously decided, that afternoon, to confer the third James Watt International Medal on Professor Dr. Aurel Stodola, of Zürich, and invited Dr. H. L. Guy, F.R.S., vice-president, and chairman of the Medal Committee, to outline briefly the reasons guiding the choice. Dr. Guy, in reviewing Professor Stodola's contributions to mechanical engineering, referred particularly to his fundamental work in connection with the turbine, more especially on the vibration of discs and blades, and expansion phenomena in nozzles. In later years, Professor Stodola had done equally outstanding work in connection with the gas turbine. This work, which will perhaps be more recently familiar to readers of ENGINEERING, since a lucid account from his pen of load tests on a 4,000-kW combustion-turbine set opened our 149th volume, in the issue of January 5, 1940. Professor Stodola, although of Slovakian birth and upbringing, has resided for many years in Zürich, where he was appointed Professor in the Mechanical Department of the Polytechnikum so long ago as 1892. The township of Zürich recognised his scientific status by making him a freeman in 1905. He holds the degree of Doctor of Philosophy of the University of Zürich, conferred upon him, *honoris causâ*, in 1901, and has received honorary degrees as Doctor of Engineering from Hanover and Brünn, and other marks of distinction from scientific societies in various European countries. He has been an honorary member of the Institution of Mechanical Engineers since 1911. The meeting was terminated by the display of a cinematograph film depicting, with appropriate commentary, the extent and varied activities of the Port of London.

MANAGERIAL SERVICE.

In the chorus of praise which, rightly, has been raised to the efforts and achievements of British workpeople in the present drive for war supplies, less attention than they deserve has been paid to the parallel services of the staffs and proprietors of our industrial undertakings. There is no reason to suppose that their contribution to the united effort is not appreciated, but, none the less, public recognition of their services has been somewhat restricted. This may be due to the relatively small number of individuals concerned, when compared with the mass of operatives. We do not know that any grievance has been felt in this matter, but that will not prevent satisfaction being expressed at the tribute paid by Sir Walter Benton Jones, in his chairman's speech at the annual general meeting of Messrs. The United Steel Companies, Limited, on October 16. Sir Walter said he had "seen little reference to the part played by the black-coated section of industry, and still less to that played by the proprietors of industrial undertakings." The skilled staff of any manufacturing concern is more than a link in the chain connecting the board of directors with the shop labourers. It is the nerve centre and brain of the whole organism, and the remarkable results which our engineering factories have shown in the last twelve months could not possibly have been attained without the ready, willing and constant service of the works managers, designers, production engineers and others who make up the technical and managerial sides of our engineering undertakings. Much discussion has taken place about the long hours being put in by workpeople, but in this important aspect of our manufacturing problem it would be neither wise nor profitable to overlook the claims of the directing and technical staffs. It is easier to modify the length of shifts than to allow for the absence of key personnel in a time of emergency, but it is to be hoped that as matters become easier some relief will be found possible for those who are coupling long hours with the constant anxiety and unending problems of an unexampled production programme. The claims to thanks and recognition of the proprietors of industrial undertakings, to whom Sir Walter referred, are of a somewhat different order. Their contribution has been a readiness to lend their personal energies and their whole organisations to a scale and speed of production of a special class which must carry with it grave problems for the future. The present emergency is not the time to discuss these, but that is no reason why the patriotic singleness of purpose of our manufacturers should fail to receive proper recognition.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

The fifty-sixth annual report of the Council of the North-East Coast Institution of Engineers and Shipbuilders for the session 1939-1940, presented at the annual general meeting held on Friday, October 18, at Newcastle-on-Tyne, indicates in various ways that the activities of the Institution are being well maintained in spite of the difficulties attendant upon a year of warfare. Twelve general meetings have been held during the session, covering a wide field with some new subjects. The student section has had eleven meetings and an exhibition of technical films. The number of members added during the session was 166, and, after deducting losses from deaths, resignations and erasures, the total number on the roll was 1,233, the most numerous grades being members, 423, associate members, 414, and students, 242. The increase in student membership is particularly encouraging. The losses by death, 21 in number, included Mr. Summers Hunter, C.B.E., and Rear-Admiral D. W. Taylor (C.C.), U.S.N. (retd.), both of whom had rendered outstanding services to engineering and naval architecture. Many members are serving in the Royal Navy, the Army, the Royal Air Force, and the Merchant Navy. As regards finance, the stability of the Institution is assured, though the balance is smaller than normal, the income amounting to 4,030*l.*, and the expenditure to 3,991*l.* The Council have instituted a Benevolent Fund under the chairmanship of Dr. John T. Batey and donations have been received amounting to 2,084*l.* up to the date of issue of the annual report. Negotiations have been carried out during the session, and are now well advanced, for a scheme of membership affiliation between the Society of Naval Architects and Marine Engineers, U.S.A., and the Institution. The first joint meeting arranged with the Institution of Engineers and Shipbuilders in Scotland was postponed. The educational work of the Institution has been carried on successfully and an Institution scholarship and a bursary have been awarded to two of the students, the Weighton Medal and Reed Medal having also been awarded to students who have shown evidence of progress in university and technical college courses. The existing scholarship holders have made very satisfactory progress. The M. C. James Medal of the Institution has been awarded to Mr. H. J. Tapsell, A.C.G.I. The library activities, though fluctuating, may, on the whole, be regarded as normal. The measured-mile posts, the custodianship of which rests with the Institution, have been repaired as necessary. The past president, Major T. Russell Cairns, has been elected a Fellow of the Institution. Mr. W. A. Woodeson was installed as President for the coming session at the annual general meeting, and delivered his address.

WINTER COAL SUPPLIES.

This time last year, both factory owners and householders were faced with a rationing scheme under which their supplies, both of solid fuel—coal and coke—and of electricity and gas, were to be limited to a fraction of what they had been in the habit of consuming. The scheme was not without its complications, some of which arose from the bureaucratic tendency to rigidity, while others were due to changes in circumstances of the consumers themselves. In the event, fuel rationing was not enforced, because the course of the war was not what was expected. On the other hand, the action of enemy submarines, unusually severe weather, and the claims of the munitions traffic laid an almost unbearable burden on the railways, with the result that in many districts there was great shortage and not a little hardship. It is, therefore, satisfactory to learn that there is a chance that this will not happen again, and that good progress has been made with a scheme for ensuring winter supplies of house coal. As is well known, both householders and merchants have been encouraged to build up stocks during the summer, and they have responded so well that at the moment these stocks are abnormally large. As regards replenishment, arrangements have been made whereby all coal merchants using the same depot will appoint a local manager, who will distribute supplies according to need, paying particular attention to those who, because they have little storage room or for other reasons, are obliged to purchase at frequent intervals. As fewer vehicles will be available for deliveries owing to the claims of the Army and the shortage of drivers, merchants are also pooling their transport. It has already been announced that the Mines Department is establishing large dumps of house coal, but these will only be utilised in real emergency. We believe that similar arrangements have been made by the electricity supply and gas undertakings, so that it is to be hoped that last winter's experiences, which were only partly due to the war, will not be repeated.

FACTORY LIGHTING IN WARTIME.

On page 152, *ante*, we published an account of the fifth report of the Departmental Committee on Lighting in Factories, which recommended a considerable increase in the present standards of interior illumination, though it is only fair to add that the figure put forward has been attained and even exceeded in many cases. A draft order, based on these recommendations, has now been made and has been sent to employers so that they may have an opportunity of stating objections before the confirmation takes place. That such reference should be made is a wise course, but it is a little difficult to see the reason for the delay in taking the step. What is called the lighting season is already upon us and it would have been well to have had the position clarified before the really long dark nights set in. It is proposed at present to apply the new regulations only to factories in which persons are regularly employed for more than 48 working hours a week, or in shifts. This does not mean, it is pointed out, that good lighting is unimportant in other factories, but, in the present circumstances, to effect the necessary improvements more generally might raise questions of priority of supplies. Where the lighting is not already up to the standards of sufficiency and suitability specified in the draft regulation its improvement is particularly important in the case of those factories in which work of special national importance is being done at high pressure, and work is carried on to an exceptional extent

by artificial light. The Chief Inspector of Factories will have power to grant exceptions from particular requirements of the regulations in special cases. Expert advice on lighting arrangements is advised by the Ministry of Labour, who state that employers may obtain it, in the case of electricity, from the local electricity supply undertaking or from the Secretary, Joint Electric Lighting Committee, 2, Savoy-hill, London, W.C.2. In the case of gas, application should be made either to the local gas undertaking or to the secretary, Joint Gas Lighting Committee, Institution of Gas Engineers, Grosvenor-place, London, S.W.1. Generally speaking, it is laid down that the general illumination over those interior parts of the factory where persons are regularly employed shall not be less than 6 ft.-candles measured in a horizontal plane at a level of 3 ft. above the floor. There is, however, a proviso that where the mounting height of the light sources for general illumination necessarily exceeds 25 ft. above the floor or where the structure of the room prevents the uniform attainment of this standard, the general illumination shall not be less than 2 ft.-candles, and where work is actually being done the illumination shall not be less than 6 ft.-candles or the greatest reasonably practicable illumination below that figure. The illumination over all other interior parts of the factory over which persons employed pass is not to be less than 0·5 ft.-candle at floor level, when and where a person is passing. Steps are to be taken to prevent glare or shadows causing eye-strain or discomfort.

THE LATE DR. C. H. MERZ.

The engineering profession has lost an outstanding figure by the death of Dr. C. H. Merz, who was killed by enemy action. In the practical applications of electricity, more particularly in its large-scale generation and transmission for industrial use and its development for railway traction, Merz was a pioneer. He had, indeed, some claim in his own sphere, to be regarded as the outstanding electrical engineer of his time.

Charles Hesterman Merz was born at Gateshead-on-Tyne on October 5, 1874. He was educated at Bootham School, York, and Armstrong College, Newcastle-on-Tyne, and received his practical training at Messrs. Robey's, of Lincoln. He was subsequently engaged at the Bankside station of the City of London Electric Lighting Company, as resident engineer at the Croydon Electricity Works, and as engineer and manager of the Cork Electric Tramways and Lighting Company. In 1899, he began his long connection with electricity supply in Newcastle-on-Tyne. Merz was the eldest son of the late Dr. J. Theodore Merz, of Newcastle-upon-Tyne, who, graduating in chemistry and philosophy, was, at his death in 1922, a philosopher of European reputation. He had, however, a very practical trend, for he was among the first to foresee the possibilities of public electricity supply for power purposes in industry, and was one of the first in this country to give the idea practical shape. The Newcastle-on-Tyne Electric Supply Company (now the North Eastern Electric Supply Company), of which he was chairman, set out definitely to attract a large-scale industrial power load among the shipyards of Tyneside. This was in 1899, at a time when the use of electricity was almost exclusively confined to business and domestic lighting.

The first step in this intuitive enterprise was the construction of the Neptune Bank power station at Wallsend-on-Tyne in 1899-1900. For this work, the subject of this obituary, C. H. Merz, acted as consultant, although he was at that time only 25 years of age. His work also covered the accompanying transmission system. The scheme was at once an engineering and commercial success. From its inception in 1899 until the day of his death, Merz remained consulting engineer to the company, from 1901 onwards his consulting practice being carried on in association with the late Colonel W. McLellan, C.B.E.

The successful pioneer enterprise in the Tyneside district was the forerunner of a number of electric power Acts which covered the whole of the industrial areas of the country and were passed in 1902-1903. Merz attempted in 1904-1905 to follow these up by co-ordinating the supply of electricity in the London area, but the Administrative County of London and District Electric Power Bill, of which he was the chief promoter, was lost through the dissolution of Parliament in the autumn of 1905. But for this, a great scheme, which is only now taking shape but was then clearly envisaged, would, beyond reasonable doubt, have constituted a further successful example of Merz's pioneering efforts. His work in the field of electric traction, to which the same adjective may be applied, was carried out in 1902 in conjunction with the late Sir George Gibb, then general manager of the North Eastern Railway Company. It covered the electrification of the suburban line between Newcastle and Tynemouth. Sir John Aspinall carried out a similar scheme on the Lancashire and Yorkshire Railway, linking Liverpool and Southport. These two electrification schemes were put into operation almost at the same time.

The connections of the firm of Messrs. Merz and McLellan are now world-wide. Before the war of 1914-18, they carried out electric power and traction schemes in Australia and South America, and, subsequent to that period, in South Africa and India. The work of the firm in this country was at first mainly associated with the North Eastern Electric Power Company, already mentioned, and later with the County of London Company, for which they designed the well-known Barking power station. Later connections were with the Central Electricity Board and a number of municipal electricity supply undertakings. In 1927-34, in conjunction with Sir Alexander Gibb and Partners, the firm promoted in Parliament, and subsequently carried through to completion, the Galloway water power scheme, which is also a pioneer development of its kind.

[*Photo: Elliott and Fry.*

The Late Dr. C. H. Merz.

In 1932, Merz had conferred on him the honorary degree of D.Sc. by Durham University. He was a member of the Institution of Civil Engineers and of the Institution of Electrical Engineers, and a vice-president of the Royal Institution, which in recent years occupied his close interest and support. The Faraday Medal was conferred on him in 1932. During the latter part of the war of 1914-18, he was Director of Experiment and Research at the Admiralty, taking a prominent part, in conjunction with his partner, Colonel McLellan, in assisting to overcome the then very acute submarine menace. For this service to the nation, Merz was offered a high honour at the end of the war; this, however, he asked leave to decline.

It is difficult in short space to summarise the late Dr. Merz's activities or to give an adequate idea of their importance. He will be remembered for his bold use of new ideas, not all of them, naturally, his own, and for his almost unfailing intuition in determining what was, and what was not, commercially practicable. The use at the North Tees power station of a steam pressure nearly double that previously employed, in conjunction with reheating and the use of air heaters, and also his introduction of high-tension armoured switchgear may serve as examples of this initiative. His commercial acumen was no less remarkable than his engineering skill and enterprise. He was inspired throughout his professional life by one purpose, which he pursued with indomitable energy, the advancement of the influence and interest of his firm and staff. This influence and interest he regarded as co-incident with those of the electrical industry as a whole. His calm, almost detached, outward manner made him a little difficult of approach, but he had an underlying kindness of heart of which many will feel the loss. On the occasion of the presentation to him of the Faraday Medal in 1932, he paid graceful and obviously sincere tribute to what he described as the self-effacing help and assistance given to him over a long period by colleagues old and new. Apart from his work, his interests were in pure science and literature. He was an early and keen motorist, but otherwise had little interest in outdoor pursuits.

THE LATE MR. M. B. BUXTON.

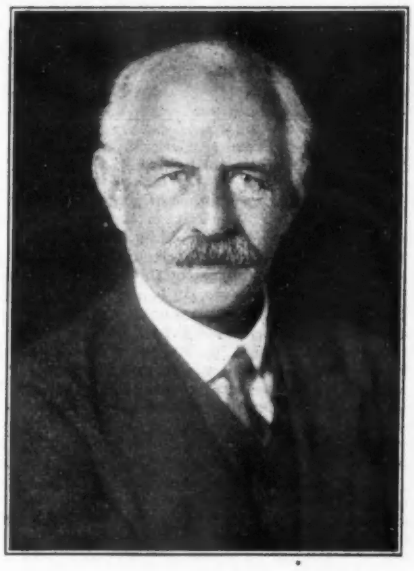
It is with great regret that we record the death, as a result of enemy action, of Mr. Murray Buxton, President of the Institution of Structural Engineers. He was 51 years of age, and had spent practically the whole of his engineering career with Messrs. H. Young and Company, Limited, Nine Elms Steelworks, Battersea, of which firm he was chairman and managing director.

Murray Barclay Buxton was educated at Repton School and at Trinity College, Cambridge, whence he graduated M.A. in 1911, with first-class honours in the Natural Science Tripos. Before going up to Cambridge, he served two years' pupilage with the late Mr. W. J. Stephenson Peach, M.I.Mech.E., but circumstances interrupted his association with the engineering profession, and he had passed 30 years of age before it was resumed. During the war years, he held a commission in the Norfolk Regiment, and saw much active service at Gallipoli, in Egypt and in Palestine, for which he received the Military Cross. He was severely wounded in 1917, and in January of the following year was invalided home. Subsequently, having recovered his health, he received a staff appointment at the War Office and, in 1919, was demobilised with the rank of captain. It was at this point that he resumed his engineering career by acquiring an interest in the Nine Elms Steelworks, of which, shortly afterwards, he became a director. At the same time he engaged himself to the firm as an assistant, in order to study the practical side of structural steelwork, and for a while was in the curious position of being virtually a pupil in the business, while occupying a seat on its board. He applied himself to the study of his chosen branch of engineering with characteristic energy and thoroughness, however, developing organising abilities which found further scope in the chairmanship of the Horsehay Company, Limited, Shropshire, and directorships of Messrs. Skipworth, Jones and Lomax, of Manchester; Messrs. Power's and Deane Ransome's, Limited, of the Lea Bridge Steelworks, London; and the Jersey Steel Company, Jersey, C.I. He had been an associate-member of the Institution of Civil Engineers since 1923, and became an associate-member of the Institution of Structural Engineers in 1924. In 1925, he was transferred to the grade of member in the latter institution, eventually being elected a member of the Council, and then vice-president. His death occurred in London, during a recent air raid, when a bomb wrecked the room in which he was sitting.

THE LATE MR. W. L. HICHENS.

SHIPBUILDING is only one of several branches of industry and public affairs which lost an administrator of unusual calibre when Mr. W. L. Hichens, chairman of Messrs. Cammell Laird and Company, Limited, was killed by an exploding bomb during a recent air raid on London. His interests were wide, and by no means confined to the immediate problems of industrial finance, which it was his business to direct; indeed, his pronouncements on the sociological aspects of the inter-relations of capital and labour, and his penetrating analyses of the principles ruling their relative remuneration and the organisation of industry as a whole, were regarded with universal respect, even by those who saw difficulties in their practical application.

William Lionel Hichens was born in 1874, and received his general education at Winchester, whence he proceeded in due course to New College, Oxford. His introduction to the direction of large-scale finance came as an appointment to the Egyptian Ministry of Finance. During the Boer War,



[*Photo: Elliott and Fry.*

THE LATE MR. W. L. HICHENS.

he served with the City Imperial Volunteers, but remained in South Africa on the termination of hostilities as treasurer of the township of Johannesburg. His successful administration of this office during a period of very rapid expansion of the town, brought him prominently to the notice of Lord Milner, then High Commissioner for South Africa, by whom he was appointed Colonial Treasurer of the Transvaal and Treasurer of the Inter-Colonial Council of the Transvaal and Orange River Colony. In 1907, he went to India as a member of the Royal Commission on Decentralisation, and, two years later, returned to South Africa to preside over a Board of Inquiry which had been set up to investigate and report upon the Public Service of Southern Rhodesia. He was still only 36 years of age when, on the conclusion of the Rhodesian inquiry, he was appointed chairman of Messrs. Cammell, Laird and Company.

As was to be expected, the appointment of one so young, and so unversed in industrial management, did not escape criticism; but the record of the next few years showed that the selection was justified. At that time, the firm was only beginning to recover from the severe slump which had affected shipbuilding and the heavy engineering industries for several years. Under Mr. Hichens' direction, the financial position was gradually improved, until, three years later, a resumption of dividends became possible. The fact that he had held the chairmanship continuously for practically 30 years is, perhaps, the best tribute that could be paid to his fitness for a position of such responsibility. During the war of 1914-18, Mr. Hichens served on the Commission on the Utilisation of the National Register and as chairman of the Central Council of Controlled Firms. In 1915, also, he visited Canada, on behalf of the Ministry of Munitions, in connection with the war-time expansion of the Canadian munitions industry; and was directly concerned with the home production of munitions as chairman of the Coventry Ordnance Works, with which Messrs. Cammell Laird and Company were associated. In recent years, he had been serving as a director of the Metropolitan-Cammell Carriage, Wagon and Finance Company, Limited, the English Steel Corporation, and the London Midland and Scottish Railway. He was also a member of the Carnegie United Kingdom Trust, an office which afforded a direct outlet for the idealism that was a part of his nature. It was not an impractical idealism, however, and a comparison of the views expressed in his James Watt Memorial Lecture, in 1918, with the subsequent events shows how accurately he could take the measure of contemporary trends.

SYNTHETIC RUBBERS.*

By LAWRENCE A. WOOD.

(*Continued from page* 317.)

THE preparation and properties of the chloroprene polymers have been described quite extensively in the scientific literature. Neoprene, formerly called Duprene, is the leading representative of this type and is widely used in the United States and in England. The Russian chloroprene polymer is called Sovprene. The chemical reactions involved in the manufacture of chloroprene are indicated by the following equations:—

$$3\,C\ (\text{coke}) + CaO\ (\text{lime}) \longrightarrow CaC_2\ (\text{calcium carbide}) + CO$$

$$+\ H_2O\ (\text{water}) \longrightarrow HC \equiv CH\ (\text{acetylene}) + CaO$$

$$+\ HC \equiv CH\ (\text{acetylene}) \longrightarrow CH \equiv C-CH=CH_2\ (\text{vinylacetylene})$$

$$+\ HCl\ (\text{hydrochloric acid}) \longrightarrow CH_2=CCl-CH=CH_2\ (\text{chloroprene})$$

Chloroprene polymerises much more rapidly than butadiene, and, with a few unimportant exceptions, somewhat more rapidly than any of the derivatives of butadiene. If the polymer is removed when polymerisation is about one-third complete, it is found to possess quite different mechanical properties from those of the completely polymerised material. The former product, the α-polymer, resembles unvulcanised rubber, while the latter, the μ-polymer, resembles vulcanised rubber. The commercial varieties of Neoprene correspond to the α-polymer, and are made by the polymerisation of chloroprene under different conditions. Neoprene G, for example, is an emulsion polymer. A very small amount of a stabilising material, commonly phenyl-β-naphthylamine, is usually added to Neoprene after polymerisation. The stabiliser prevents continued polymerisation, or more particularly cross-linking or cyclisation, which would cause a stiffening of the Neoprene during storage. Plasticisers are frequently added in small amounts for the purpose of enabling the material to be processed more conveniently with the usual rubber machinery.

When Neoprene is heated it undergoes a permanent change in physical properties similar to that involved in the vulcanisation of rubber. The chloroprene polymers are unique among rubbers, synthetic or natural, in that this process can occur without the addition of other materials. In commercial practice, however, it is found more desirable to add a number of compounding ingredients. Several of the metallic oxides, such as magnesium oxide, zinc oxide, and litharge, function as vulcanising agents, rather than sulphur, which, when used, acts as an accelerator. Many of the organic accelerators used with natural rubber are not effective with Neoprene, but catechol and some similar substances are said to be promising substitutes. The addition of carbon black, which is usually found desirable, makes a stiffer compound, but, contrary to its effect with natural rubber, it does not increase the tensile strength. It has not been found possible to vulcanise Neoprene to a state corresponding to ebonite, or hard rubber. Compounding materials are mixed with Neoprene by means of the usual rubber machinery, but its behaviour on milling is somewhat different. Neoprene E and the types previously produced appear to be unaffected by mastication, the softening which occurs being caused merely by the elevation of temperature. The newer types, G, G W, and G N, may be substantially softened by mastication.

Butadiene, either alone or in combination with other substances, is the source of almost all the synthetic rubber manufactured in Europe. Butadiene, a gas at temperatures above —5 deg. C., is being manufactured by a number of different methods. One method involves the pyrolysis ("cracking") of petroleum, especially the higher-boiling constituents. Under the proper conditions the process yields butadiene directly. The crude butadiene is then subjected to purification. This process is used in the manufacture of the Russian rubber called "S K A," and it is reported to be the one which the Standard Oil Company is planning to use in the United States for the manufacture of a rubber similar to Perbunan. A dehydrogenation of some of the lower-boiling constituents of petroleum has also been described, but has not yet been put into commercial practice. In another important method, alcohol is converted into butadiene by a reaction indicated by the following equation:—

$$2\,C_2H_5OH\ (\text{alcohol}) \rightarrow CH_2=CH-CH=CH_2\ (\text{butadiene}) + 2\,H_2O + H_2,$$

The butadiene, used in the manufacture of the Russian rubber S K B, is prepared in this manner from alcohol obtained by the fermentation of grain or potatoes.

The polymerisation of an impure material yields a product of low molecular weight, presumably because the formation of long chains is interrupted by the impurity. It is very difficult to obtain butadiene of high purity from petroleum products, especially when they are secured from cracking operations, or from agricultural products, particularly when they are obtained by fermentation. This fact is one of the major causes of difficulty and expense in the manufacture of butadiene from these sources.

One possible process for the manufacture of butadiene from acetylene is similar to that already given for the manufacture of chloroprene, except for the substitution of hydrogen for hydrochloric acid in the last step. However, the reactions of the process actually used most extensively in Germany are indicated by the following equations:—

$$3\,C\ (\text{coke}) + CaO\ (\text{lime}) \longrightarrow CaC_2\ (\text{calcium carbide}) + CO$$

$$+\ H_2O\ (\text{water}) \longrightarrow HC \equiv CH\ (\text{acetylene}) + CaO$$

$$+\ H_2O\ (\text{water}) \longrightarrow CH_3-CHO\ (\text{acetaldehyde})$$

$$+\ CH_3-CHO\ (\text{acetaldehyde}) \rightarrow CH_3-CHOH-CH_2-CHO\ (\text{aldol})$$

$$+\ 2\,H \rightarrow CH_3-CH(OH)-CH_2-CH_2OH\ (\text{butanediol or butylene glycol})$$

$$\longrightarrow CH_2=CH-CH=CH_2\ (\text{butadiene}) + 2\,H_2O$$

Although long, the process is said to be free from side reactions and to yield butadiene of high purity. The first reaction is carried out in a furnace for which large amounts of electric energy are required. The cost of the electric energy is probably one of the largest items in the whole process. In another process, reported to be in use in Germany, the acetylene is said to be extracted from coke-oven gases.

For the products known as Buna 85, Buna 115, SKA, and SKB, polymerisation of butadiene is carried out with metallic sodium as the catalyst. Emulsion polymerisation is used for Buna S and Perbunan. The co-polymers Buna S and Perbunan contain 20 per cent. to 40 per cent. of styrene or acrylonitrile, respectively. Polymerisation, in addition to the formation of the long chains, leads to a certain amount of cross-linking, or cyclisation. The continuation of cyclisation during storage of the raw material is prevented by the addition of a very small amount of a stabiliser, phenyl-β-napthylamine being almost always used.

Buna S and Perbunan, in the uncompounded state, are somewhat stiffer than natural rubber, and they behave somewhat differently during processing in the usual rubber machinery. Heating Buna S to a temperature of 130 deg. to 150 deg. C. for one or two hours in the presence of air, produces a temporary change known as thermal oxidative softening, which is of very con-

* *Synthetic Rubbers: A Review of Their Compositions, Properties and Uses.* Circular C 427 of the United States National Bureau of Standards. Washington, D.C.: The Superintendent of Documents. [Price 10 cents.] Abridged.

250-KVA. RESISTANCE WELDING MACHINE.

MESSRS. METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, MANCHESTER.

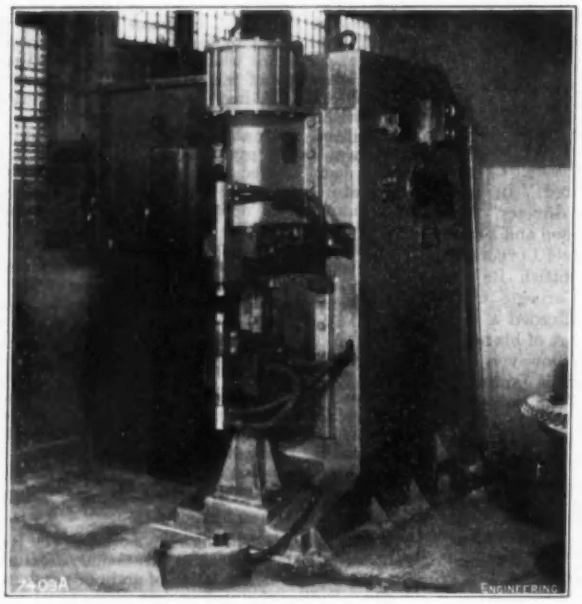


Fig. 1.

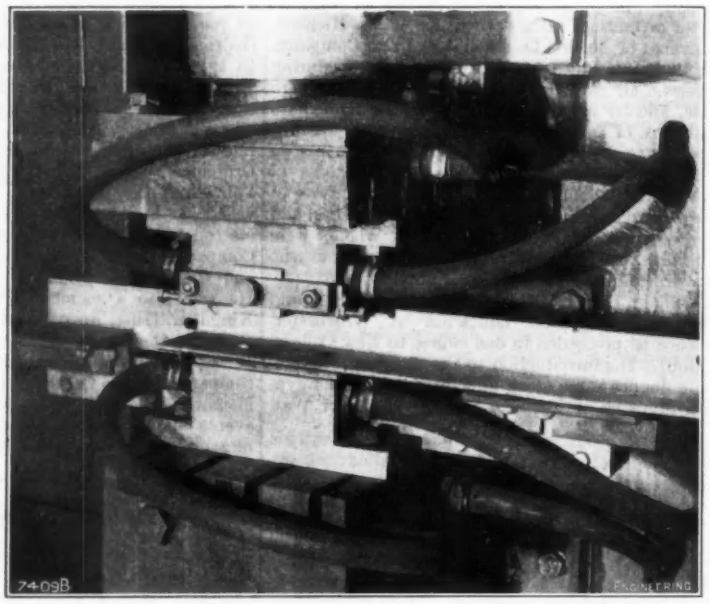


Fig. 2.

siderable importance in the technology of this material. Since such a treatment is not effective with Perbunan, various softeners are usually added to facilitate processing.

Vulcanisation of the butadiene polymers is carried out with sulphur as the vulcanising agent, together with zinc oxide and organic accelerators. With sufficient sulphur, compounds of the ebonite type can be made. In these respects the butadiene polymers are similar to natural rubber and differ from Neoprene. The ebonite made from the Buna rubber is said to soften at a higher temperature than that made from natural rubber.

The condensation reactions of organic dihalides with sodium tetrasulphide indicated by the equations shown in Table II (page 317, *ante*) are typical of a large number of reactions for obtaining substances which, although bearing no chemical relation to natural rubber, conform to the definition of synthetic rubber already given. Certain products of this type are given the trade name Thiokol in the United States, and Perduren in Germany. In each unit of these compounds, two sulphur atoms are part of the main chain, while the two others are attached to them and are not part of the main chain. If the latter two sulphur atoms are removed by chemical means, Thiokol A yields an inextensible product, but Thiokol B yields material which is still extensible and is sold as Thiokol D. Perduren G is similar to Thiokol B, while Perduren H is formed by the reaction of di(chloroethyl) formaldehyde acetal with sodium tetrasulphide. Perduren L is a mixture of Perduren and Perbunan. A Japanese product, Thionite, is obtained from the reaction of ethylene diglycoside with sodium tetrasulphide. Vulcaplas is an organic polysulphide made in England by the reaction of glycerol dichlorohydrin with sodium tetrasulphide or similar sulphides. The raw material from which many of the polysulphide rubbers are made are relatively cheap. The sodium tetrasulphide is obtained from the reaction of caustic soda and sulphur; the organic dichlorides are produced from common organic compounds and chlorine. The chlorine is obtained from salt and many of the organic compounds can be obtained from natural gas.

(To be continued.)

Glass-to-Metal Joints.—An account of a method of producing soldered metal-to-glass seals is given by Mr. S. T. Martin, Junr., in a recent issue of the *Review of Scientific Instruments*. A coating of silver is first applied to the glass and the surface is then tinned with soft solder, using a flux consisting of an aqueous solution of tartaric acid with some glycerine. The method has been employed to fasten a Pyrex liquid-air trap to a metal vacuum system and also to introduce high-voltage electric leads through porcelain insulators. It is claimed that the joints are as vacuum-tight as other soldered joints. They are, moreover, stronger than waxed joints.

250-KVA. RESISTANCE WELDING MACHINE.

It is common knowledge that considerable progress has, of recent years, been made in the development of electric welding technique. Indeed, it is not going too far to say that a stage of perfection has now been reached which will be of inestimable value in the present emergency. Nevertheless, any factor which will improve the speed or quality of the work or simplify the means of accomplishing it is still very welcome. In fact, such procedure as re-casting the drawing office specifications so that welding may be beneficially employed in directions that at first seem unlikely and the adaptation of machines to special requirements are well worth consideration. The Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, have employed welding from the earliest days and in furthering their own practice in the shops have developed machines and a technique of considerable value. The result prompted them to become suppliers of these machines, and their activities in the design of arc-welding equipment are by now well known. The potentialities of the various resistance-welding systems are now becoming more and more recognised, especially in the direction of the precise control of the welding heat and process. It will, therefore, be of interest to indicate something of what the company is doing in this direction by describing a machine which has been designed for heavy spot and projection welding.

This machine is illustrated in Fig. 1 with spot-welding electrodes in position. These electrodes are carried by substantial castings which are bolted to the top and bottom platens. They are removed altogether when the machine is used for projection welding, their place being taken by suitably designed contact blocks. Such contact blocks for fastening angle brackets on to large angle sections are illustrated in Fig. 2. As will be seen, the machine is of robust construction and is fitted with a supporting jack for the bottom platen. There is also a heavy-section top arm to withstand the reaction from the direct-acting air cylinder. This cylinder is 12 in. in diameter and is supplied with air at a pressure of 80 lb. per square inch to exert a maximum pressure of 9,000 lb. between the platens. A rectangular guide for the top electrode assembly can be fitted if desired.

The welding transformer, which is rated at 250 kVA, is housed within the frame of machine and is interesting from the fact that the secondary winding consists of a copper tube of square section. This winding is suitably formed and brazed into cast-copper headers, thus forming a system through which the cooling water circulates. The primary winding of the transformer has five tappings and a series-parallel connection, all of which are connected to a double-unit tapping switch mounted on the frame. In this way, it is claimed, a wide range of welding current is placed at the operator's disposal. Alternative systems of control are available for this machine. When it is desired to employ straightforward projection welding, a scheme including a suitable contactor and an accurate timing device for controlling the duration of the weld is quite satisfactory. Where, however, it is intended to use the machine on rather more complicated work, and particularly when the spot welding of heavy sections has to be undertaken, it is an advantage to employ "interrupted spot welding." This method, commonly known as "woodpecker" control, has been rendered possible by the development of synchronous timing devices which, having no moving parts and therefore no inertia, permit the instantaneous switching of heavy currents. Briefly, the process allows the application of repeated current impulses, instead of a single application, in the making of a weld. For this purpose, a suitable Ignitron control panel is used, so that a certain predetermined number of power impulses can be applied each of which is synchronously timed. There is an adjustable "off period" between each pair of impulses.

Several advantages are claimed for this system. In the first place, it increases the life of the electrodes many times when heavy sections are being spot welded. In the second place, it allows any given machine to weld greater thicknesses of material, while in the third place, it is beneficial on certain jobs which tend to flash or blow out weld metal during the passage of the welding current. It can be readily understood that when spot welding thick pieces of steel together, the heat generated, combined with the high pressure applied to the electrode tips, tends to cause the material to anneal and the tips to mushroom out and sometimes to fuse to the steel. While, with the interrupted current, the time between the impulses allows the water flowing to the electrodes to control the temperature of the electrode tips, the interval is not sufficient to lose appreciable heat from the inside surfaces of the plates where the weld is being formed.

The system employed with the machine illustrated consists of an "Ignitron Woodpecker" cubicle for controlling the welding current and a small panel which houses two Thyratron-controlled relays for adjusting the time at which set-up pressure is applied, and the length of the forging period. The latter is the time of pressure "dwell" after the weld is completed and before the electrodes are allowed to separate. The air cylinder is double-acting and air reservoirs are built into the top of the machine frame to supply air at the required pressure to the top and bottom of the operating piston. By employing electrically-operated air valves, it is possible to obtain a differential pressure on the piston if desired, as well as to exhaust the air underneath it at any desired stage of the weld cycle by means of the Thyratron relay in order to apply a sudden pressure increase to the electrodes. This "upset pressure" is of value in consolidating welds made in the thicker sheets and in obtaining a flush joint on projection-welded assemblies.

LABOUR NOTES.

THE Ministry of Labour and National Service announces that the number of persons who were registered as wholly unemployed at September 16 was approximately the same as at August 12, being 613,671 for September, as compared with 613,156 for August. At September 16 there were 185,000 workers on short time or otherwise temporarily suspended from work on the understanding that they were shortly to return to their former employment. This figure was an increase of 30,620 as compared with August 12. The number of unemployed casual workers on the register was slightly less at September 16 than at August 12, being 31,175 as compared with 31,916. The only industry in which there was any considerable increase in unemployment was coal-mining.

Of the 613,671 wholly unemployed, 318,234 were men, 25,145 boys, 227,293 women, and 42,999 girls; the 185,000 temporarily stopped included 97,548 men, 3,056 boys, 78,995 women, and 5,401 girls, and the 31,175 casual workers, 29,486 men, 110 boys, 1,561 women, and 18 girls. Between August 12 and September 16 the numbers of unemployed on the registers increased by 7,193 in the London area, 6,473 in the Eastern area, 4,315 in the Southern area, 3,846 in the South-Western area, 4,807 in the North Midlands, 12,043 in the Northern area, and 579 in Wales. They decreased by 5,080 in the Midlands, 115 in the Eastern area, 3,047 in the North-Western area, and 620 in Scotland.

In September, the home-branch membership of the Amalgamated Engineering Union increased from 430,889 to 437,264, and the Colonial-branch membership from 38,390 to 39,113. The number of members in receipt of sick benefit increased from 3,952 to 4,186, and the numbers in receipt of superannuation benefit decreased from 13,490 to 13,464. The number in receipt of donation benefit increased from 481 to 520, and the total number of unemployed members decreased from 2,561 to 2,502.

Mr. Tanner, the president of the organisation, states in the October issue of the Amalgamated Engineering Union's *Journal* that, arising out of discussions which the executive council had with the Director of the Engineering and Allied Employers' National Federation, "at which the Union contended that consultation should take place prior to the introduction of women into federated establishments," the matter was referred for consideration to the Management Board of the employers' organisation. "A letter has now been received from the employers," Mr. Tanner goes on to say, "intimating that while they cannot accept the contention of the union, they take the view that there is no substantial reason why the men should not be informed of a firm's intention when they propose to bring in women, in terms of the agreement of May 22, 1940. The employers state that it must be obvious that in the great majority of cases, preparations have to be made for the introduction of women, and there is no particular reason why the proposal to introduce them should not be disclosed to the representatives of the male workers likely to work in conjunction with the women or be associated with them." Mr. Tanner adds that the Federation's decision on the matter "is to be conveyed to its members."

The writer of an editorial note in the October issue of the Amalgamated Engineering Union's *Journal* says:—"A great deal of nonsense has been talked and written about the unwillingness of workers to carry on with their jobs during air-raid alarms. There is, of course, everything to be said for reducing the time lost by interruptions of this nature to the lowest practical minimum. But a dead or badly injured worker is a total loss where production is in question, whereas the worker who sensibly seeks shelter when danger is imminent is available for production when the 'all clear' signal sounds. Furthermore, it is not within the competence of workers, intent upon their jobs, to be able to tell when danger is imminent. They must go by the signals. If the 'banshee wailings' of the sirens sound too often and without real cause that is not the fault of the worker. Proper signalling of approaching danger and reasonable provisions to enable them to seek shelter are all that the workers demand."

Workers, the writer continues, "did not ask for more." "They wanted to be assured," he says, "that injuries sustained by carrying on with the job must not invalidate their rights to compensation. Air-raid casualties were not compensation cases arising out of employment and occupation. The Government has now put the matter right by laying it down that men who are injured if they carry on after air-raid warnings have sounded will have the right to claim for compensation under the Government scheme and also will be able to claim under any known life insurance policy covering war risks. This is good, so far as it goes, though we consider that all insurance contracts under which workers pay real money for benefits upon injury or death should be extended to air-raid risks without qualification. If the right arrangements are made the workers will carry on."

An agreement reached by employers and operatives on the terms of payment to operatives for time lost during air raids has been ratified at Blackburn by the central committee of the Northern Counties Textile Trades Federation, representing trade unions in the manufacturing section of the Lancashire cotton industry. The scheme, which is similar to that reached by the parties in the spinning section of the industry, provides for full rates of wages for the first 2½ hours lost during a working week, and 75 per cent. of the wages for additional time lost, up to a maximum of 10 hours a week. The agreement is retrospective to September 2.

According to Mr. Walter C. Burdett, the Counsellor of the American Embassy at Rio de Janeiro, the normal working day for all personnel on board the vessels of the Brazilian merchant marine is one of eight hours, with compensatory leave, or payment of corresponding wages, for overtime. The eight-hour day has been in operation for sailors and firemen since 1915, but in the latest decree its benefits are extended to stewards. During each legal 24-hour day, the seaman may be kept at his post for eight hours, such service to be either continuous or intermittent, at the discretion of the commander, but intermittent duty is never to be less than one hour. Duties in connection with cabins, engines, passage ways, watch, and any others which medical opinion considers prejudicial to the health of the seaman are to be performed in shifts of not more than, and with intervals not longer than, four hours. All time over eight hours of effective service is to be considered overtime and entitled to compensation with the corresponding wage, or with compensatory leave on the next day or subsequent days during normal working days, or at the end of the trip. Overtime performed in entering and leaving ports is not to exceed 30 hours per week.

In a statement of the principles on which, in its opinion, labour affairs should be regulated during the war, the Committee of the Privy Council of Canada suggested that there should be no interruption in productive or distributive operations on account of strikes or lockouts. Where any difference arises which cannot be settled by negotiation between the parties, assistance in effecting a settlement should be sought, it said, from the Government conciliation services, and, failing settlement of the difference in this manner, it should be dealt with in accordance with the provisions of the Industrial Disputes Investigation Act, which has been extended under the War Measures Act to apply specifically to all war work. Employees should be free to organise in trade unions, free from any control by employers or their agents. In this connection, attention was directed to Section 11 of the provisions of Chapter 30, 3 George VI, an Act to Amend the Criminal Code, under which it is declared to be an offence, subject to prescribed penalties, for any employer, or his agent, wrongfully and without lawful authority to refuse to employ or dismiss from employment, any person because of his membership in a lawful trade union, or to intimidate or prevent a workman from belonging to a trade union.

Employees, through the officers of their trade union or through other representatives chosen by them, should be free, the statement continued, to negotiate with employers or the representatives of employers' associations concerning rates of pay, hours of labour and other working conditions, with a view to the conclusion of a collective agreement. Every collective agreement should provide machinery for the settlement of disputes arising out of the agreement, and for its renewal or revision, and both parties should scrupulously observe the terms and conditions of any agreement into which they have entered.

By a Canadian Order in Council provision has been made for the establishment of a War-time Industries Control Board and for the appointment of controllers for the major industries. The Board is responsible for organising the services of, and the available agencies for, the supply of munitions, and the controllers are to exercise for their respective industries some of the wide powers of the Minister of Munitions and Supply to conserve, co-ordinate, restrict and regulate certain essential supplies.

THE CONVERSION OF PETROL VEHICLES TO OPERATE ON LOW-PRESSURE TOWN GAS.*

By E. A. C. CHAMBERLAIN, Ph.D., D.I.C.

WHEN a simple conversion of a petrol vehicle is undertaken, it is understood that minimum alterations will be made to the engine, and that either petrol or gas may be used at will. The primary consideration of such a conversion is that the cost of the alterations shall be as low as possible consistent with reasonable performance on the alternative fuel, and that the performance on petrol shall not be adversely affected by any of the alterations made. Secondly, it is important that any driver should be able to change from one fuel to another easily and rapidly. These restrictions operate against optimum performance on gas, and possible improvements in engine performace have to be rejected in view of high cost of alteration or resulting difficulties when running on petrol. However, the last year has shown that the simple conversion can be most successful, and that the limitations imposed do not seriously affect the value of gas as an alternative fuel. The low-pressure system can, therefore, make a valuable contribution to the national economy of petrol. In presenting this paper an attempt has been made to discuss some of the theoretical and practical problems which have arisen and to indicate what developments have taken place during the past year.

The power development of a particular engine is entirely dependent on the properties of the fuel supplied to it, and will vary with different fuels. It has been found that town gas gives a smaller power output than petrol, and it has been thought advisable to review the theoretical considerations involved in order to check the experimental results obtained on the test bed. The chief considerations are:—(1) The net calorific value of the fuel-air mixture; (2) the specific volume change on combustion; (3) the specific heats of the products of combustion and the degree of dissociation at high temperatures; (4) the latent heat of evaporation of the fuel if liquid; (5) the specific gravity of the fuel-air mixture; (6) the radiation from the flame and hot products.

The two fuels between which comparison has been made are No. 3 petrol, as specified in *Technical Data on Fuel*, and town gas of the following analysis:—CO_2, 2·5; O_2, 0·6; C_3H_6, 2·6; CO, 10·8; CH_4, 21·1; C_2H_6, 0·7; H_2, 54·4; and N_2, 7·0. Calorific value: 500 B.Th.U. cub. ft. gross, 456 B.Th.U. net. When running on gas, the fuel-air ratio for optimum power is about 1 : 4·1 by volume, so that the fuel-air mixture entering the cylinder on each induction stroke consists of 80 per cent. air and 20 per cent. fuel. On petrol, the fuel enters in the form of a heavy vapour occupying under 2 per cent. of the total volume inspirated. There is, therefore, in effect, a loss in volumetric efficiency when operating on gas.

The figures in Table I are taken as a basis of comparison between the two fuels:—

TABLE I.

——	No. 3 Petrol.	Town Gas.
Calorific value of theoretical fuel-air mixture (air 60 per cent. RH., 60 deg. F.).	95·0 B.Th.U. per cub. ft.	85·2 B.Th.U. per cub. ft.
Specific volume change on combustion, *i.e.*, volume of products net at S.T.P. volume of mixture at S.T.P.	1·062	0·915
Mean specific heat of products of combustion, 0–2,200 deg. C.	0·02385 B.Th.U. per cub. ft.	0·0244 B.Th.U. per cub. ft.
Latent heat of evaporation	254 B.Th.U. per lb.	—
Specific gravity of the fuel-air mixture (air = 1).	1·04	0·89

It is not possible to estimate singly the effect of the factors (1) to (6), since they are all inter-dependent, but it is possible to indicate their general significance. The difference in calorific value of the fuel-air mixtures is 10·3 per cent., and this is the most important of the factors tending to reduce the power output on gas, but it must be considered in conjunction with factors (2) and (3). The specific volume change indicates an expansion of 6·2 per cent. on petrol and a contraction of 8·5 per cent. with gas, so that the ratio of volumes after combustion is 0·861. This factor obviously reacts in favour of petrol, since it tends to give a bigger pressure development in the cylinder with a lower working temperature. However, the higher specific heat of the products of combustion of town gas tend to reduce the flame temperatures. The combined effect of these three factors may be considered as

* Paper presented to the Institute of Fuel. Abridged.

OPERATION OF PETROL VEHICLES ON TOWN GAS.

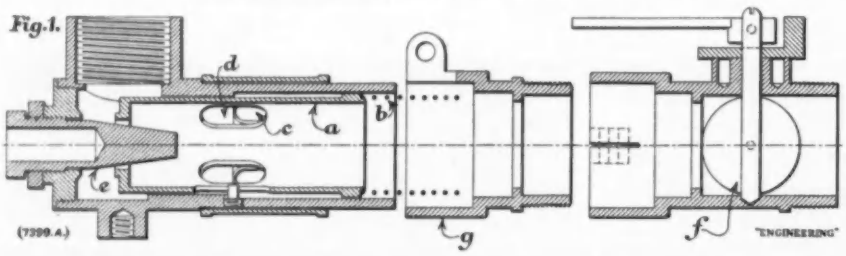


Fig. 3. Morris 12/4 Van with Box Crate.

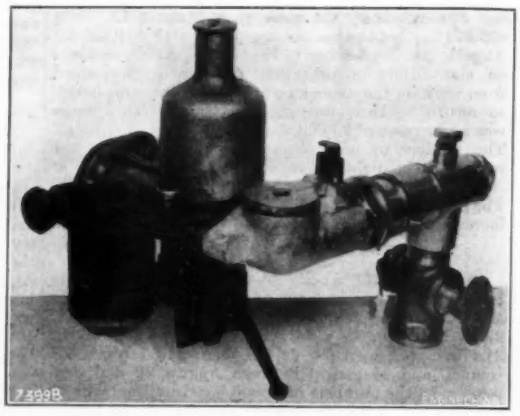


Fig. 2. Gas Carburettor.

follows :—The theoretical flame temperature (ignoring dissociation) is, with petrol, 2,080 deg. C. (2,353 deg. abs.); gas, 2,120 deg. C. (2,393 deg. abs.). The effect of this difference on the pressure development is of the order of 1·5 per cent. in favour of gas. Considered in conjunction with the ratio of volumes after combustion of 0·861, the ratio of pressures developed at constant volume under these ideal conditions will be :—$0{\cdot}861 \times 1{\cdot}015 = 0{\cdot}875$; so that the pressure development on gas is less by 12·5 per cent.

It is interesting to note the effect of rich mixtures on the specific volume change which occurs with both gas and petrol. Taking, for example, town gas, as shown in Table II :—

Table II.

——	Theoretical Mixture for Complete Combustion.		
Air-gas ratio ..	4·3 : 1	4 : 1	3·5 : 1
Specific volume change	0·915	0·956	0·974
Potential heat in combustion products	Nil	8·6 per cent.	22·4 per cent.

This increase is due to the larger number of molecules owing to the existence of some carbon monoxide and hydrogen in place of carbon dioxide and water vapour. The actual power developed will, of course, depend on the balance between the increase in the specific volume change and the decrease due to the loss of heat developed. The figures given indicate that the maximum-power mixture will be about 4·1 : 1. The Gas Light and Coke Company has found in experiments on a Commer 14/4 and an Austin 16/6 car that the maximum power is obtained with the mixture giving an exhaust analysis of 10 per cent. CO_2 and 1·4 per cent. CO on gas of the composition previously given. This corresponds to an air-gas ratio of 4·14 : 1, a result very close to that obtained theoretically.

The latent heat of evaporation of the fuel has a considerable effect on the volumetric efficiency of the engine, since with petrol the air-fuel charge is cooled by about 28 deg. C. If the temperature of the charge drawn into the cylinder is taken as 380 deg. abs., the result of this cooling effect is to increase the volumetric efficiency by about 7 per cent. On gas this intrinsic cooling effect is absent, and the working temperature of the cylinder will also be higher; so it may be anticipated that the warming of the entering charge by convection on the cylinder walls will be greater with gas than with petrol and that the temperature difference will be increased. The differences in viscosity and specific gravity of the air-fuel mixture will become important as far as these factors influence the discharge characteristics of the two mixtures through the valve gear. It is not possible to calculate for a general case the value of this effect, but the equivalent effect on any engine will be inversely proportional to the square roots of the densities of the two mixtures. Here the advantage lies with town gas.

It is necessary at this point to consider what differences exist in the energy dissipation with gas and with petrol. Little information is available on the conduction from hot gases to the cylinder walls under the conditions of turbulence that exist in an engine cylinder. At low temperatures (100 deg. C. to 500 deg. C.) the rate of cooling is proportional to the temperature difference between the hot gases and the walls of the cylinder. The percentage loss by conduction will, therefore, vary as the surface volume ratio of the cylinder, and will therefore be lower as the diameter of the cylinder increases, an important factor when comparison is made between the large-bore gas engine and the relatively small-bore multi-cylinder high-speed petrol engine converted to gas. At elevated temperatures, however, the simple temperature difference relationship is not valid. According to David, the rate of cooling increases rapidly at higher temperatures, being proportional to the second power of the temperature difference at 1,500 deg. C. and to as much as the fifth power at 2,400 deg. C. It will be realised, therefore, that though the calculated flame temperatures of gas and petrol differ by only 40 deg. C., the effect on the conduction losses may well be more significant.

The radiation losses may be considered as arising primarily from the carbon dioxide and water vapour contents of the explosion products. As pointed out by Bone and Townend, it might be supposed that as gases under suitable conditions are capable of absorbing the radiations which they emit, they would, therefore, be opaque to such radiations; but it must be remembered that the molecules are relatively far apart, and hence a large percentage of the radiations escapes. Callendar arrived at the conclusion that the emission from a gas layer 5 cm. thick at 20 atmospheres, would be within $\frac{1}{2}$ per cent. of that from an infinite depth. It is possible, therefore, to calculate approximately the radiation for the two air-fuel mixtures being considered.

The exhaust gas analysis (wet) at the theoretical fuel-air ratio for petrol and town gas is as shown in the following Table III :

Table III.

——	Petrol.	Town Gas.
CO_2	12·9	9·9
H_2O	13·3	20·4
N_2	73·8	69·7

The difference is appreciable, and in practice it will be still further emphasised by the CO and H_2 present in the products from petrol which will reduce the CO_2 and H_2O percentages. As an example, the radiation from the two exhaust gases has been calculated for a pressure of 20 atmospheres at 2,500 deg. C. with a radiating layer 6 cm. deep. Under conditions of identical flame temperature there is, with gas, 23·6 per cent. more radiation from the products of combustion. It should be remembered that this computation ignores radiation from incandescent carbon particles in the flame. It has not been possible to obtain any figures of direct conduction and radiation losses from an engine operating on gas or petrol, but a determination of jacket losses shows that there is a greater heat loss to the walls when operating on gas than on petrol.

The optimum power setting on a petrol engine requires a rich fuel-air mixture, and, as a result, an appreciable part of the exhaust loss is made up of potential energy of unburned gases, but, if two engines are running on petrol and town gas at equal thermal efficiencies, the amount of sensible heat is greater on gas than on petrol. From several considerations, it is possible to express the percentage power loss on simple conversion of a petrol engine to gas in the form :—

$$\text{Loss per cent.} = 100\ (1 - f \times \text{volumetric efficiency ratio} \times \text{F}),$$

where f = a factor involving calorific value of the fuel-air mixtures, specific heat of the products of combustion and specific volume change. In other words, f = the ratio of pressures developed by explosion of equal volumes of the two fuel-air mixtures at constant volume.

F = an indeterminate factor involving flame characteristics convection and radiation losses, greater than unity and power loss $= 100\ (1 - 0{\cdot}875 \times 0{\cdot}93 \times \text{F}) = 100\ (1 - 0{\cdot}814\ \text{F})$.

It is therefore to be expected that, under the conditions of simple conversion, the power loss will not be less than

$$100\ (1 - 0{\cdot}814) \text{ per cent.}$$

Power loss = 18·6 per cent. of the power on petrol.

A number of independent determinations of power on gas and petrol have been examined. Our own test results on unmodified engines may be summarised as given in Table IV, opposite.

The various results indicate that the loss of power on typical small high-speed engines is greater than on the larger cylinder type of slow-running engine. It is therefore possible to anticipate that the power losses on vehicles converted to town gas will be :—

(1) Lorries with slow-running engines, 15 per cent. to 20 per cent.

(2) Light vans and private cars, 20 per cent. to 30 per cent.

Heat not converted into work raises the temperature of the cooling water and of the exhaust gas, so that the higher the efficiency, the lower the waste heat. This effect is bigger than is at first evident. The conversion of a petrol engine does not necessarily reduce the thermal efficiency; indeed, under the right conditions,

TABLE IV.

Engine.	R.p.m.	Gas.	Petrol.	Per cent. Power Loss on Gas.
Commer 14/4 ..	2,500	20·1	30·0	33·0
Austin 16/6 ..	2,500	30·2	39·4	23·4
M.G. Sports ..	4,500	30·2	42·0	28·0

slightly higher efficiencies than with petrol can be obtained. With simple conversions these conditions are not attained. As a result, it appears that the efficiencies of gas conversions are often slightly lower than on petrol. Dynamometer tests show that between 25 cub. ft. and 30 cub. ft. per brake horse-power may be expected for a normal conversion. Our own results on the Austin 16-6 running on Pool petrol indicate a consumption of 0·65 to 0·7 pint per brake horse-power per hour, giving efficiencies between 20·9 per cent. and 19·4 per cent.

It has been found on road tests with vehicles fitted with manual ignition control (Ford 24·9-h.p. van and a Morris Commercial 14-h.p. van) that the optimum ignition setting on gas was only slightly in advance of that for petrol, whereas it is generally considered that a large ignition advance is desirable. A test on the Austin 16/6 gave the results shown in Table V.

TABLE V.

R.p.m.	B.h.p.	Cub. Ft. per B.h.p.	Ignition Timing.
1,500	19·5	26·35	1 deg. after T.D.C.
1,500	19·5	26·75	6 deg. before T.D.C.
1,500	19·15	27·25	11 deg. " "
1,500	18·35	29·40	16 deg. " "
1,500	17·78	31·2	21 deg. " "
1,500	16·72	34·7	26 deg. " "
1,500	14·68	38·3	36 deg. " "
1,500	12·50	44·8	46 deg. " "

Following this test, attempts were made to recover part of the power loss at the advanced ignition settings by re-adjusting the air-gas ratio delivered by the carburettor, but no significant improvement could be obtained. It appears, therefore, that though it is possible on gas to obtain higher thermal efficiencies by working with weak mixtures and a large ignition advance, this result can only be obtained at the expense of power output.

Since an engine tends to run hotter on gas than on petrol, it is sometimes found that, with gas, pre-ignition occurs due to plugs overheating. Usually, any trouble can be cured by setting plug gaps to 15/1,000 in., and advancing the ignition slightly. Small engines, up to 12 h.p., on certain makes of vehicle, are sometimes difficult to cure by this means, and plugs with higher heat dissipation are required. Table VI shows the plugs recommended:—

TABLE VI.

Maker.	14 mm.	
	Standard.	Gas.
K.L.G.	F 50	F 70 X
Lodge	C 14	H.D. 14 H.B. 14 (Sintox)
Champion	L 10	L 10 S, LA 10

This list covers ½-in. reach plugs only, and makers' lists should be consulted for information on other plugs.

The term "gas carburettor," though incorrect, has been universally accepted for its petrol counterpart, the more accurate one "air gas proportioner" being too clumsy for general use, while "mixer" has been found to cause some confusion. The minimum requirements of a gas carburettor are:—(1) To give a constant air-gas ratio over the whole range of operation. (2) To cut off the gas when the engine is stationary. (3) To give immediate response to throttle variations. (4) To provide easy starting, steady idling, and freedom from stalling on disengaging the clutch or after braking. (5) To have a low intrinsic resistance to gas flow in order to permit as large a volume of explosive mixture as possible to be drawn into the engine.

All these requirements must be fulfilled, and the problem of design is complicated by the necessity of producing a carburettor that can be fitted to engines of widely different design and horse-power, and which must be capable of adjustment over a wide range of air-gas ratios. Several suitable carburettors are available which fulfil these conditions, and, as an example, Fig. 1, opposite, illustrates the G.L.C. No. 2 carburettor, suitable for use on engines developing up to 60 brake horse-power. Its method of operation is as follows:—The suction of the engine moves the piston *a* against the spring *b*; air then enters through the adjustable air ports *c* and the corresponding slots *d* in the piston. Gas enters through the annular space between the cone *e* and the piston. The fuel-air mixture passes to the engine via the butterfly control *f* or the petrol carburettor adaptor *g*.

The fuel-air ratio is determined by the angle of the cone: the larger the angle, the richer the mixture. A trimming adjustment for the air-gas mixture is provided by the air shutter. The cone has a short parallel section to enable the mixture to be adjusted for slow-running conditions. Withdrawing the cone enriches the mixture at low engine speeds only, and this adjustment should not be used to increase the gas supply under load conditions, as the correct air-gas ratio will not then be maintained. It should be remembered that with gas there is no condensation of the fuel in the induction system when starting a cold engine, and that there is therefore no need for a choke or other means for obtaining a temporarily rich mixture.

Experience with many different types of vehicle, especially those with engines fitted with S.U. petrol carburettors, has shown that the most satisfactory method of fixing the gas carburettor is by means of a Tee fitted into the air intake of the petrol carburettor. One limb of the Tee carries the gas carburettor with a bush, as in Fig. 1, and the other limb a release valve which can be tripped in the open position to act as the air inlet when running on petrol. This method of fixing is shown in Fig. 2. By this means no alteration is made to the throttle control and the slow-running adjustment of the throttle remains the same for both petrol and gas. In addition, it is unnecessary to seal off the gas carburettor when running on petrol. The alternative method of fixing is to make a connection direct into the induction manifold by means of an elbow using the butterfly fitting. This method entails fixing alternative throttle controls, and it has been found to increase the probability of air leaks through the petrol carburettor, with consequent difficulty in maintaining correct air-gas ratio control. In our opinion, this method should only be adopted when the first cannot be used.

Two-stroke and single-cylinder four-stroke engines do not operate satisfactorily with the standard G.L.C. carburettor, since the suction in the induction manifold is discontinuous and the carburettor slider tends to oscillate with the engine piston. The problem has been solved by fitting the gas carburettor in the petrol carburettor air inlet, and operating the gas carburettor slider by a Bowden control fitted in series with the petrol carburettor butterfly throttle.

Before discussing road results after conversion it is necessary to consider the design and construction of the gas bag and its support, since these have a marked effect on performance. When designing the gas container, the bag and the crate must be considered as an integral unit which must fulfil the following conditions:—(1) The bag must store sufficient gas to give a reasonable mileage between fills. (2) The bag must at all times be under control, so that it collapses regularly and at no time must the material block the gas outlet. (3) The bag and crate must be constructed so that strain due to wind currents when the vehicle is in motion is reduced to a minimum. (4) The friction between the bag and crate must be as little as possible, and the bag should be reinforced wherever rubbing cannot be avoided.

Much experimental work has been done to ensure that the gas bag collapses inside the crate in such a way that the bag can be completely emptied without the gas outlet becoming blocked by the fabric. With the wooden box crate of the type shown in Fig. 3, this object is achieved by leaving the front of the box open so that wind pressure acting on the front of the bag forces the gas to the back. The gas connection is then made at the back of the bag, the fabric being supported on the sides of the box in the vicinity of the outlet to prevent it becoming blocked when the bag is nearly empty. If a solid front is fitted to the crate, not only is the wind resistance increased, but eddy effects when the vehicle is in motion produce no regular pressure on the bag which may collapse at any point, a fact which makes the location of the gas outlet difficult. The difficulty may be overcome by fixing perforated tubes along the floor of the bag connected to the gas outlet or by placing a cane basket over the outlet inside the bag; but it is far simpler to adopt the system first described.

(To be continued.)

LEADERSHIP AND DIRECTION IN INDUSTRY.*

By WILFRID AYRE.

(Concluded from page 318.)

PRODUCTION efficiency, with particular reference to factory organisation, is rarely regarded as having the same degree of importance as, say, the design and subsequent performance of some product for which a performance guarantee is required and cheerfully given. One of the first steps in the co-ordination of production is to determine a "target" or measurable standard of production within the capacity of the plant. Whatever the unit of measurement, it should be capable of computation and inspection on a weekly basis. In shipbuilding, for example, the basis might be gross tonnage, deadweight carrying capacity, steel tonnage or riveting output. The ability to assess with reasonable accuracy a "target" rate of production and to measure its progress week by week is the essential element of planning and production control. The technique of planning has been literally forced on productive industries of every description by the inescapable necessity for greater efficiency. Without planning there can be no effective control of output, and without control there can be no efficiency in manufacture. Planning must envisage the whole scope of operations from ordering of materials to final delivery of ship or engines. No item of "sequencing" of manufacturing processes should be considered unimportant enough to justify omission from the scheme of planning. In shipbuilding, to take one example, progress in riveting—a cardinal index of production—is, to a very material extent, affected by the timeous fitting of small items, such as angle lugs, packing slips, watertight shoes, screwing up of work, reamering of odd holes or preparation of staging.

The problem of labour control and management is another obvious and important responsibility of leadership. Mere supervision is not nearly enough. As an essential for co-ordination there must be goodwill between management and the service of labour. This can be best achieved by real practical evidence of efficiency in works administration and due recognition of the part which labour plays in the plan of production. The output which we can expect from the inanimate machine depends on how we treat it. It is psychologically true that the same is the case with labour. Workmen will never fail to give of their best if their interest in the production problem is properly aroused and they are allowed to enjoy the feeling that real effort will be adequately remunerated. Methods of remuneration vary as between industries, depending on the class of goods produced. Piece-work is, in some respects, an important aspect of shipbuilding, but no piece-work system can ever hope to be a substitute for efficient planning and co-ordination. Payment by results in shipbuilding is often a one-sided affair. When operatives succeed by the combined efforts of themselves, their foremen and the management in making good earnings, all is well, but the inequity of the system is that, unless piece-workers of varying degrees of skill receive for their efforts wages at a rate considerably above a so-called standard time rate, then piece-work price lists cease to apply and a lieu rate is demanded and usually paid. In support of this, it can be stated that there is practically no such thing as a standard time rate for piece-working trades in shipbuilding, no matter what the degree of skill possessed by the operatives. Lieu rates are given to tradesmen who, in return, are supposed to work with piece-work speed, but this latter phase is only one of the delusions of the "time and a bit" system.

An appreciation of the state of world economics ranks largely among the responsibilities of industrial leadership; and these have not been lessened by the tendency in recent years for trade to become more and more affected by international considerations. It is, after all, the very existence of trade that creates the demand for production, and it is trade which permits the eventual disposal of the result of production. Production of itself can never earn profit, so it may be convenient here to recall that under existing economics the only possible alternative to regular profit making in industry is the broad, easy and slippery road to bankruptcy. The product of industry has to be sold for what it will realise, and the level of profit, if any, depends on extent of demand, production cost, value or attractiveness assessed by the purchaser, and skill of salesmen. This cycle of demand, production and disposal is beset by commercial problems of many kinds. One of the primary functions of commerce is to create demand for the products of industry. The wealth of a nation depends in a large measure on this. But demand does not always exist at a level which

* Presidential address to the Institution of Engineers and Shipbuilders in Scotland. Delivered in Glasgow on Tuesday, October 15, 1940. Abridged.

satisfies the economic production level of a factory. It is then that measures—schemes, we may call them—for stimulating demand are most needed. Among the most effective schemes in shipbuilding have been the creation of new designs offering improved performance, and possessing promise of overcoming those elements which operate in the depressed portion of a trade cycle; financial accommodation to promote faith in a venture, and a selling price level that will attract and will reduce operating loss.

On salesmanship must be placed responsibility for the development of an ever-increasing circle of clients and the ability to decide the most effective methods of marketing and publicity; the two go hand in hand, sensing the pulse of competition coupled with intelligent appreciation of the purchaser's future needs. Of other commercial matters which require administrative attention, some relate to commercial law and the legal and moral obligations of contract; others to the purchasing of materials and sub-contracting, or matters affecting insurance, manufacturing or sales policy. In the sphere of accountancy and finance, questions of cost determination, estimating, taxation, disposal of profits, allocations to depreciation and reserves are, again, matters which are essential functions of administration and indeed have a vital bearing on the financial structure responsible for the means of production.

I seriously doubt whether the shipbuilding and marine-engineering industries have yet reached the stage where the potentialities of what may be called an articulated organisation in relation to the production problem are fully appreciated. The fault may not be attributable in the final analysis to real lack of enthusiasm or driving force on the part of the "accused"; rather may it be because the subject of industrial organisation in its fullest sense in relation to the production problem in shipbuilding and marine engineering has not, up to now, been regarded as of any greater importance than, say, the operations of frame bending, riveting and hull erection, of engine machining and assembling, or of technical problems associated with ship and engine design.

It must be acknowledged that, in the present framework of the shipbuilding and marine-engineering industries, there are but restricted opportunities available to promising young men, not yet risen to positions of responsibility, for acquiring knowledge of, or experience in, the problems of organisation, production and commerce. Furthermore, the facilities available for technical education in naval architecture and marine engineering provide little or no opportunities for study of, or acquiring proficiency in, commercial and administrative problems of industry, such as accountancy and commercial law, production control and functions of management, salesmanship and general principles of business policy.

This battle of production will not be decided by the outcome of the present war. It will continue far into the post-war era. The present time is, therefore, most opportune to propose that the Board of Education, our universities, or our technical institutions, should, without delay, establish a degree course or National Certificate in Production and Commercial Practice in Shipbuilding and Marine Engineering, quite independent and apart from existing science degree courses in naval architecture and engineering. In the changed and changing world in which we now live, where industry, commerce, finance and even politics play more vital parts than at any other time in our history, there would, indeed, appear to be ample justification for some recasting of the present university curriculum for a science degree, which gives proficiency in what is really only a single phase of shipbuilding or marine-engineering practice. The structure of such a degree course, in my view, largely fails to reach full stature, if only because, due to the curriculum limitations, it completely neglects that general standard of business competency which is so essential to-day for industrial direction or leadership.

The Institute of Export.—A Manchester Branch of the Institute of Export has recently been constituted and the inaugural meeting was held on October 17. The Chairman of the Manchester Committee is Mr. A. E. Marsh and the secretary Mr. C. J. Shepherd, 48-50, Mosley-street, Manchester, 2.

Fray Milling Machines and Accessories.—The Broadway Engineering Company, Limited, Carlisle-road, Hendon, London, N.W.9, have sent us a copy of a booklet dealing with the "All Angle" milling machines, attachments and accessories, manufactured by the Fray Machine Tool Company, Glendale, California, U.S.A., for whom they are the sole European agents. Although the booklet is only of waistcoat-pocket size, it contains illustrations and descriptions of machine tools and numerous attachments set up for grinding, end-milling, drilling, keyseating, slotting and thread-milling operations.

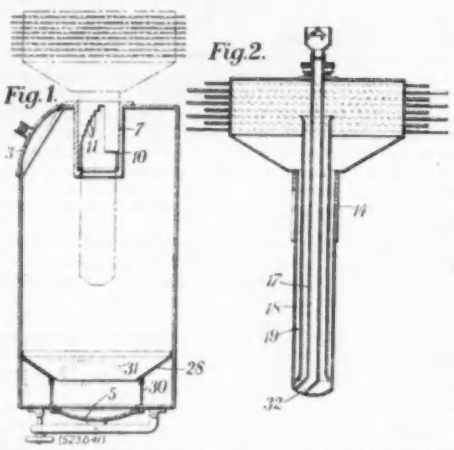
"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.
Where inventions are communicated from abroad, the Names, etc., of the communicators are given in italics.
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.
The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

FURNACE APPARATUS.

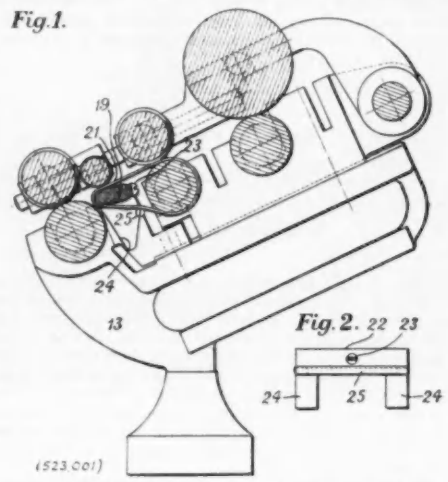
523,041. Gas Producer for Vehicles. The Gas Light and Coke Company, of Westminster, and H. M. Lawrence, of Westminster. (6 *Figs.*) December 23 1938.—Considerable trouble is experienced with gas producers for vehicles from the formation of clinker round the point of entry of the air blast, and it is an object of the invention to minimise interference from this source in the operation of the producer. The cylindrical producer casing has a charging door 3 at its upper end and an ash and clinker door 5 at its lower end. Through a gastight joint in the top of the casing passes a cylindrical sleeve 7 internally shouldered at its lower end. Within the sleeve 7 is a lining 10 with spiral steps 11. The lining 10 rests on a greased asbestos packing on the internal shoulder. A sleeve 14 is secured to the upper end of the tuyere (Fig. 2) and is provided with steps which engage the steps of the sleeve so that by lifting and turning the tuyere it can be raised or lowered. The sleeve 14 and the lining 10 are a sliding fit within the sleeve 7. The



tuyere is formed of two coaxial cylinders 17 and 18, connected at their lower end and separated by a cylinder 19, the lower end of which is flared outwards and serrated. The lower end of the cylinder 17 is bent and forms an air nozzle 32, so that when the tuyere is moved up or down and is at the same time rotated, the stream of air sweeps over a greater area of the fuel bed than if the lower end of the cylinder were straight. The cylinder 19 extends about half-way up into the water reservoir at the top of the cylinder 18. In operation, when the water at the lower end of the tuyere gets hot, the currents of warm water and bubbles are deflected into the inner chamber between cylinders 17 and 19 and pass upwards through it, while the colder water is drawn down through the outer chamber between cylinders 18 and 19 so that circulation of the cooling water is set up. The producer has at its lower end a lining 28 of conical form (Fig. 1), and the gas produced passes down through this lining and thence through openings in a cylinder 30 to the tangential outlet pipe 31. (*Accepted July* 3, 1940.)

TEXTILE MACHINERY.

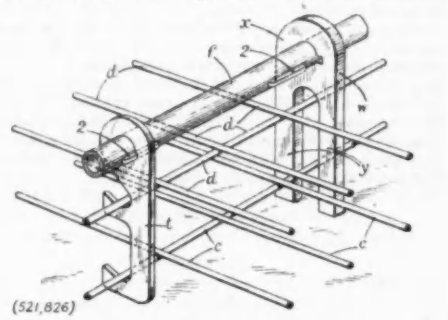
523,001. Drawing Head for Spinning Frames. Platt Brothers and Company, Limited, of Oldham, J. Hughes, and W. H. Watson, of Oldham. (6 *Figs.*) December 20, 1938.—The drawing head forms part of a high-draft drawing apparatus as employed in spinning frames and in which a small endless leather band running round a nose-bar is employed as a guide for roving in the roller stand. The top and bottom rollers are mounted in the usual manner in the roller stand 13 and an idle pressure roller is loosely mounted over the nose-bar 19, which is supported in brackets on the stand. The nose-bar is of elongated cross-section with rounded ends. An endless leather band 21 runs over the middle roller and round the tension device on the nose-bar. The tension device consists of a spring-steel guide bracket 22 clipped on to the nose-bar and held in place by a screw 23. Both rounded edges of the nose-bar are covered for the full width of the leather band. Beyond the edges of the band, two arms 24 project downwards for a short distance



and are then bent up again so that their free ends can carry a tensioning pin 25, which presses against the underside of the band 21 and tensions it. The degree of tensioning is variable by bending the arms 24. (*Accepted July* 3, 1940.)

MISCELLANEOUS.

521,826. Laying Reinforced Concrete. J. H. Walker, of London. (8 *Figs.*) November 29, 1938.—This invention is an apparatus for positioning reinforcing bars or mats preparatory to the casting of reinforced concrete slabs in situ, such as roads, floors and other comparatively large areas. The reinforced concrete is assumed to be cast on the road-bed between side forms in a slab of a width approximately half that of the road, the thickness of the slab being about 10 in., with a layer of steel reinforcement *c* at about 2 in. above the bottom of the slab and another *d* at about 2 in. below the top of the slab. The two layers *c*, *d* of reinforcing material are placed on the levelled road-bed in mats of considerable length. A number of transverse steel support tubes *f* are then supported at their ends on the side forms at intervals along the road-bed. Each tube *f* is provided with an external key 2 and has threaded on to it sets of depending double hooks *t* of sheet metal. The upper hook supports the upper reinforcing mat *d* and the lower hook supports the lower mat *c*. The ends of the tubes *f* are supported on packing blocks resting on the



side forms and are drilled to take tommy bars. In operation, the upper reinforcing mat *d* is lifted from the road-bed and some of its transverse bars are engaged with the upper hooks. When a convenient length of the upper reinforcing mat has thus been suspended, the lower mat is similarly lifted and its transverse bars engaged with the lower hooks. The full thickness of concrete is then cast in place and while it is still wet the tubes *f* are first lowered slightly by removing the packing blocks and are then rocked by tommy bars to swing the hooks out from the concrete. The tubes with the hooks on them can then be arranged at a fresh location to take the uncovered portions of the upper and lower reinforcing mats. If the size of mesh of the mats is large, the men engaged in the work may stand on the road-bed, but if the mesh is small planks must be laid across the tubes so that the men may work from these planks. Tubes of the same diameter are used for both wide and narrow concrete slabs, the tubes in the former case being provided with intermediate supports *w*. These have top parts *x*, drilled to thread on to the tubes, and legs *y* which stand on the road-bed and straddle the bars of the reinforcing mats. (*Accepted May* 31, 1940.)